Wind Pressure.

The disastrous consequences which have befallen structures designed with every care for their safety with the exception of their stability to resist the pressure of extraordinary gales, are a sufficient apology for drawing the attention of architects and engineers to the subject. Considerable difference of opinion prevails with respect to the actual pressure of wind. As one writer has asserted, most of the experiments that have been made have been conducted upon unsatisfactory methods. They have been carried out by the use of test-plates, the pressures registered being by means of the resistance of springs attached to the plates, which introduce a factor of uncertainty much below the actual pressure. It was lately proposed to sling the enormous girders of the Tay Bridge for the purpose of measuring the real pressure of wind, regardless of the fact that the mere inertia of so great a mass would not be overcome by moderate winds, and the test would, therefore, be of little use. The actual conditions of the bridge would not be realized by such means, as the girder would not be rigidly fixed, and its effect upon the lower part of the structure or the piers rendered of little account. The effect of a sudden gust of wind upon a plate girder would be that part of the wind would be arrested and part pass over and part under the girder. But in an actual bridge the lower surface of the platform is exposed, and if there should be a series of cells or hollows made by the cross girders and stringers, these cavities will receive a part of the force, and the pressure will be enormously increased. The test-plate with four edges would have four lines of discharge, and, as Mr. Graham in his "Graphic Statics" has said, if the four lines of discharge be reduced to one, it would be no exaggeration to add one-fourth of the registered test-plate pressure for every line of discharge cut off. Thus, a test-plate pressure of 30 pounds per square foot would be increased to 52.5 pounds when striking a cellular surface, such as that of a bridge floor. Engineers have apparently overlooked the effect on the return sides of their structures, also the effect due to an uneven surface of girder made of cells and flanges. If we take a solid plate girder, such as those of our railway bridges, with top, bottom, and end flanges, the difference between it and a test-plate is apparent; the wind is prevented from escaping, and a more effective head of pressure occurs, which must be considered.

The same principle applies in the case of a building, the surface of which is divided by breaks, columns, and cornices, forming a cellular surface. Yet we have been accustomed to treat the front of such a building as a plain wall with four lines of discharge, and to reckon the pressure upon it at so much per foot square. The effect of the ground and adjacent buildings is to increase the normal pressure also, and these circumstances ought to be taken into account.

In the report of the committee appointed to consider the question of wind pressure in railway structures no reference is made to the formation of the girders in these particulars, any further than the extent of surface, close or open, and we may usefully give here the results arrived at. High winds only were dealt with, and it was found that "the greatest pressure recorded in an hour was tolerably well proportioned to the square of the mean velocity during the hour, and that the empirical formula $\frac{V^2}{100} = P$ (where V = maximum run in miles of the wind in one hour and P = maximum pressure in pound on the square foot at any time during the storm) represented fairly the greatest pressure as deduced from the mean velocity for an hour." For railway bridges and viaducts a maximum pressure of 56 pounds per square foot is assumed for the purpose of calculation, which represents a velocity of 75 miles an hour. This pressure is to be applied to close girders, the whole vertical surface of one main girder being taken, supposing the top of the girder to be as high, or higher, than the top of train passing over the bridge; but if the top of train is higher than the top of main girder, the full wind pressure is to be applied to the entire vertical surface from the bottom of girders to the top of train. Where the bridge or viaduct is of the lattice or open construction, the pressure upon the outward or windward girder is to be ascertained by applying the full pressure of 56 pounds per foot, as if it were a close girder from the level of rails to the top of the passing train, and by applying, in addition, the same pressure per foot to the vertical surface of the ironwork of the same girder below the level of rails or above the top of train passing. With respect of the inner or leeward girders, a scale of pressures is given to be applied to the ascertained vertical areas of ironwork of one girder situated below the level of rails or above the top of train passing, as follows: (*a*) "If the surface area of the open spaces does not exceed two-thirds of the whole area included within the outline of the girder, the pressure should be taken at 28 pounds per square foot. (*b*) If the surface area of open spaces lie between two-thirds and three-fourths of the whole area, the pressure should be taken at 42 pounds per square foot. (*c*) If the surface area of the open spaces be greater than three-fourths of the whole area, the pressure should be taken at the full pressure of 56 pounds per square foot." Arches and piers of bridges are to be calculated to stand the same pressure ascertained in conformity with these rules. A margin of safety in respect of such strains is to be given to these structures of four times the amount calculated, and in cases where the tendency of the wind to overturn structures is counteracted by gravity alone a factor of safety of two is sufficient.

As we have observed, these rules take no account of uneven surfaces, which necessarily, by impeding the discharge of the wind, are subjected to more pressure, and if 56 pounds per foot is a fair calculation for plain smooth surfaces, honeycombed or irregular surfaces ought to be calculated at a higher rate. There is more danger to be apprehended from an accumulated head of wind than a sharp gust with ample means of escape for the current. We have a good field for more experiments under the conditions we have mentioned, and it may be of service at least to insist upon the importance of architects and engineers adopting a margin of safety in their works which present a large and broken surface to the wind. There are many viaducts constructed with open or close girders which could not withstand a pressure upon them of 56 pounds per square foot, calculated by the Board of Trade's rules, and allowing for the margin of safety. A pressure of twice the amount would overturn them. The effect of a horizontal pressure is analogous to that of a vertical load. If we imagine the outer girders upon which the wind strikes braced together horizontally, they, in fact, become huge horizontal girders, the piers taking the reactions. The force exercises a cross strain upon the piers in a manner very trying to their strength. We have first to find the reactions at the tops of the piers due to a wind pressure or load uniformly distributed, each reaction being of course equal to half the pressure. If we consider each reaction, we shall find it gives rise to a bending moment, one end of the pier being fixed at the bottom, and the other free to move, producing on the leeward edge of pier a concentration of pressure, and tending to overturn it at that point. Here we have, in fact, the weak point. On the windward side of the bridge there is an uplifting action, tending to raise the masonry or tear it asunder from a weak bed joint; while, on the other side, the whole pier has a tendency to turn on the edge and to give rise to a crushing action. Are the piers of viaducts constructed to resist this double action of tearing asunder and resisting crushing? If the pier is able to withstand the latter force, there are ten chances to one it cannot resist the upward pull on the windward side. The stones are seldom cramped or tied together, though a considerable moment of force would be exercised in a structure like that of the Bouble viaduct, which is 183 feet high to the underside of the girders. The need of anchoring iron piers to their masonry pedestals has been significantly shown in several instances. It has been calculated, for example, in the case of the Bouble viaduct that, allowing for a wind pressure of 55.3 pounds per square foot upon the solid parts of girders, on the train and on the half pier, the total turning power on the leeward edge would be 9,188, and that, putting against this the moments of stability due to the weight of pier and train, there would be a deficiency of 1,688, which has to be provided for by an anchorage tension of at least 24.69 tons. We refer the reader to M. Goudard's paper on the Bouble viaduct in the Minutes of Proceedings of the Institution of Civil Engineers.

In architectural structures there is quite as much care necessary to insure proper anchorage for the foundations of walls, shafts, and erections of considerable height. In the arch form of bridge the wind pressure has less effect than on a straight girder, owing to the shape of the solid parts, the pressure being less in the center or the crown of arch. On the other hand an excess of pressure would occur in the bowstring form of girder, when the greatest surface is in the center of the span. Such a form occurs commonly in the gabled ends of railway sheds and stations. The form of spires, steeples, and domical structures of tapering outline happily brings the center of pressure down below the middle and reduces the moment of force. A round or polygonal shaft on plan has the advantage of receiving less pressure, a circular tower receiving about two-thirds of that upon a square tower of the same diameter. The effect of winds on roofs of different pitches is one of the chief considerations with the architect. The greatest pressure likely to be borne by a roof of a high pitch, say 60°, has been calculated to be about 23½ pounds, though the current of wind, if in a downward direction, would create a considerably greater pressure. To take the slope of a steep church roof, the pressure on one side might seriously strain the framing. To give the roof sufficient resistance, good principal rafters, well framed, and stout purlins are necessary. Experiments have shown that the more elevated the structure the greater is the wind pressure. A pressure of 56 pounds has been supposed to be correct for an elevation of 200 feet. At a less height, say of 15 feet, the pressure would be about 20 pounds if we took the curve of pressures. We have, therefore, a rule of some certainty to guide us in proportioning our structures to the height above ground, and hence no pressure could be adopted as proper for all elevations or for all surfaces. The subject is deserving of more attention than has been given to it. Although not a constant force, wind is one of those uncertain elements which is practically neglected altogether, but which every structure at some time or other of its existence, has to encounter.—*Building News.*

DIVING BELL.—The earliest account of a Diving-bell is found in Schotts *Technica Curiosa*, Nuremburg, 1664, in which is described the decent of two Greeks in "a very large kettle suspended mouth down." This experiment took place in the harbor of Toledo, Spain, in 1538, before the Emperor Charles V. Dr. Halley, about 1717, invented a leather helmet for divers, connected by a flexible tube with the diving-bell.

THE TAY BRIDGE.

On the Machinery and Methods for Founding the Piers of the New Tay Bridge.

In the construction of the foundations for large bridges in a tidal river where boisterous weather and strong currents exert their full force, and are seldom long absent, great difficulties have always been experienced, involving serious trouble and expense, as well as loss of time and material in constructing staging sufficient to act as a platform for the execution of the work. Previous experience of these difficulties in other cases, and a careful forecast of their character in the case of the new Tay Bridge, has led to the designing and construction of a peculiar staging or movable platform by Mr. Arrol, the contractor for that structure. These platforms have proved equal to all the work required of them, and have withstood the severity of wind and current without any mishaps. With the design, the construction, and working of these platforms, the present article proposes to deal. The largest will be selected for description, the others being all on the same principle, only varying in size.

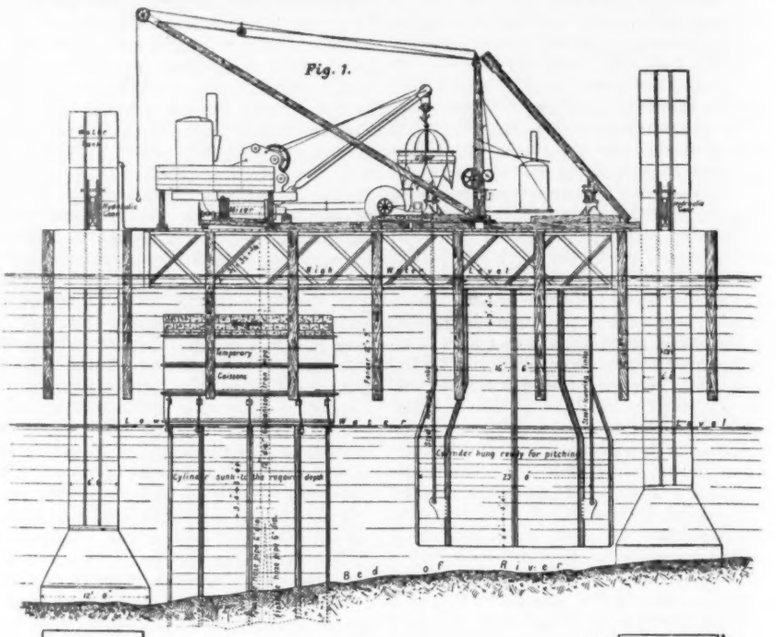
In order to form an idea of the work to be done and the methods and appliances for executing it, reference may be made to Fig. 1, this view being a cross elevation of one of the piers of the new structure. The lower part, with which this paper is intended to deal, consists of two cylindrical shafts sunk into the bed of the river, these being carried up to low-water level, while on them are erected brick pillars, which are united in one at high-water level to form a continuous cross structure on which the superstructure of the bridge is to rest.

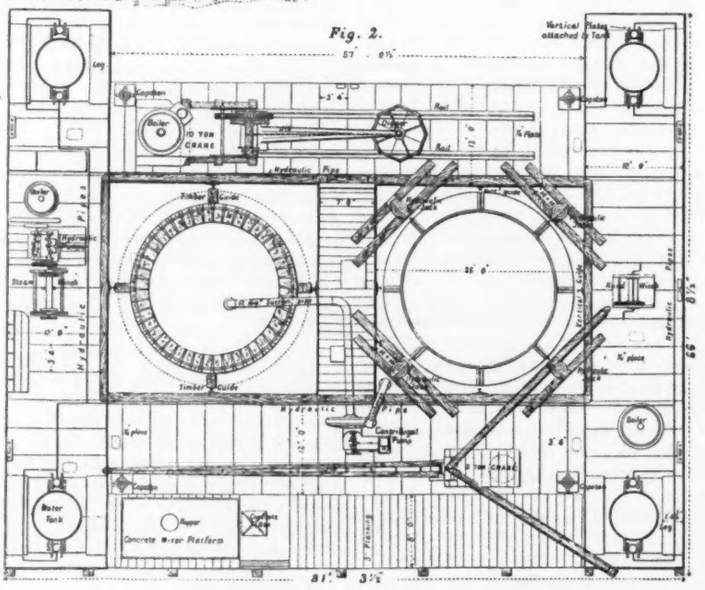
The cylindrical shafts as sunk into the river bed are formed primarily of wrought-iron cylinders built up in annular sections as the work of sinking them proceeds. The first section placed in position is provided with a cutting edge, so that when the material within it is removed, and additional rings are added to it, the superincumbent weight causes it to descend. When these cylinders have been sunk to their proper depth they are filled with concrete, thus forming a cylindrical shaft encircled with an iron tube. To sink those cylinders truly, and to handle easily and safely the materials for the brickwork and concreting, was the work for which the appliances about to be described were designed.

The "movable platforms" (of which there are four at work) vary in size from 56 feet long by 36 feet 6 inches broad and 6 feet deep, as in the case of the smallest, to 81 feet long by 66 feet broad and 7 feet deep in the case of the largest. The essential feature in the construction of these platforms is that of uniting in one solid structure five water tight iron tanks, somewhat in the form of the letter H, each member of the letter representing a tank, while one tank is added at each end, thus forming two openings, corresponding to the position which the shafts of the pier occupy in horizontal plan. (See Figs. 1 and 2.) In the large platform these openings are 25 feet square, and adapted to a pitch of 32 feet centers of the shafts forming the pier. The two main tanks which form the ends are each constructed of a length equal to the breadth of the platform, and in the case of the largest which is being described are 12 feet broad by 7 feet deep.

Near to either extremity of these end tanks are openings 8 feet 4 inches by 6 feet 6 inches, through which are passed the columns or legs which support the platform of the river bed, and on which it is suspended at varying heights by hydraulic gear to clear it from the action of the tides. By this combination of water-tight tanks in rectangular form, suspended on four cylindrical columns or "legs," there is formed what is really an amphibious staging, rigid at one time on the bed of the river, ready at another to raise its own "legs" or supports and sail away to another position of action.

FIGS. 1 AND 2.—FOUNDATION PLANT, NEW TAY BRIDGE.



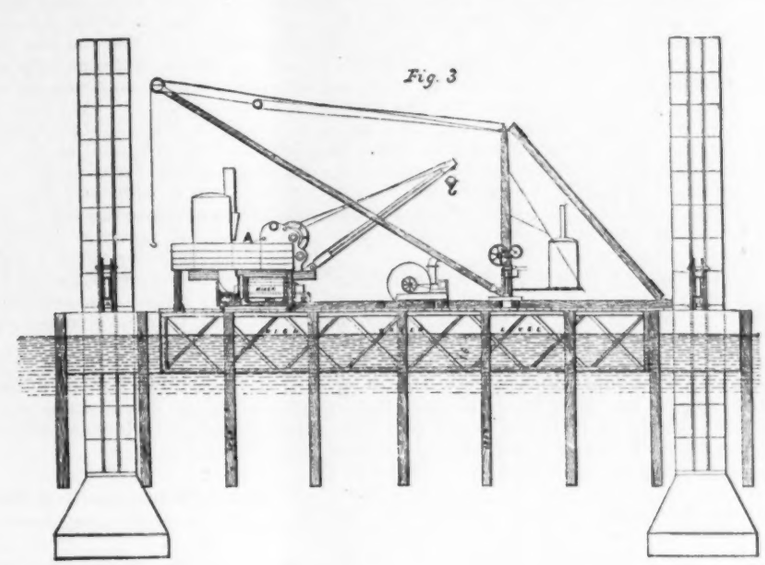


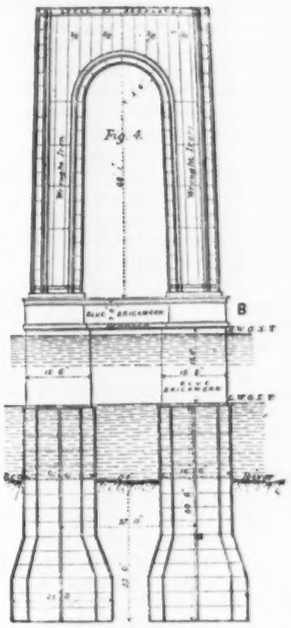
On the platform thus constructed the following plant is arranged. On the end tanks are placed the engine and boilers for actuating the hydraulic and other pumps, and a workshop for renewal or repair of tools. The two side tanks which join the end tanks having a breadth of 12 feet by the common depth 7 feet, carry the cranes, the concrete mixer, a centrifugal pump, etc., an additional breadth of 8 feet being got on one of these tanks by the arrangement of a girder and planking, etc. On the center bank, which has a length of 25 feet by 7 feet broad and 7 feet deep, there is fitted a shelter for the men. At the opening in the end tanks through which the "legs" pass there are fitted steel plates in a vertical position, and to these are fixed the hydraulic gear for raising and lowering the platform. These are shown more particularly in plan in Fig. 2.

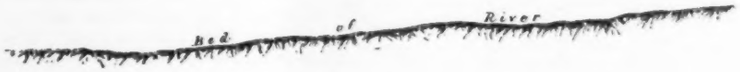
The "legs" of this platform are 65 feet long and 6 feet in diameter, with a conical shaped foot or bottom, 12 feet in diameter. These "legs" are simply strong tubes open at bottom, so as to exert a cutting tendency when loaded, but fitted inside with a transverse plate at a distance of 30 inches up from the cutting edge to prevent the "leg" from sinking too deep into the sand or gravel of the bed of the river. After many experiments with different shapes of feet, this arrangement was found to be the best, as the scour was trifling. It may be mentioned that in the construction of the South Esk Viaduct (a quarter of a mile) in length) at Montrose by the same contractor a "movable platform" was also used which had flat bases on its supports 12 feet square, as the bed of the river was of a gravelly nature, and there was no chance of scour.

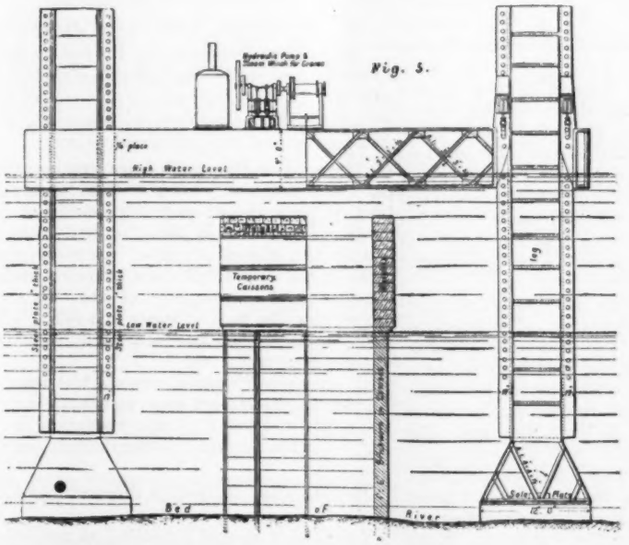
To the supporting "legs" or columns are attached four heavy steel plates in two opposite pairs having a distance of 21 inches between them; in these plates are cut holes 5¼ inches in diameter, and spaced at 9 inch centers, through which are passed the steel pins by which the platform is suspended. Sliding within these plates are the two plates before mentioned as attached to the platform which carries the hydraulic gear; these having also holes of the same diameter and pitch as the plates on the "legs," and also a slot opposite the cross-head to admit of the vertical travel of the pin. The suspension pins are five inches in diameter and 30 inches long, and are provided with a tapered point to facilitate their entrance into the holes.

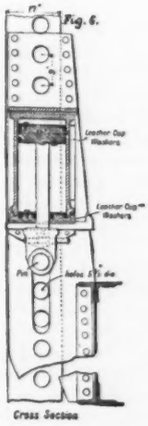
FIGS. 3-10.—FOUNDATION PLANT, NEW TAY BRIDGE.

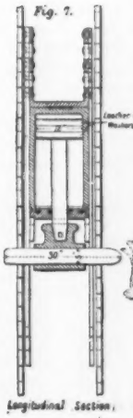


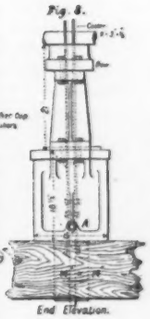


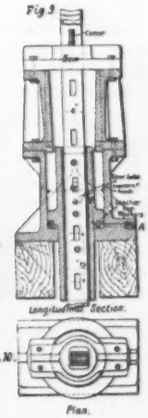












The hydraulic gears, of which there are two for each "leg," wrought simultaneously, consist of a cylinder, 12 inches in diameter, piston, piston-rod, open cross-head, and the necessary valves for actuating them. (See Figs. 6 and 7.)

The mode of raising or lowering the platform is as follows: Suppose the piston to be at the top of the cylinder, a suspension pin is passed through the two outer plates and the crosshead. Water is then admitted, and the cylinder is forced up because the outer plates are fixed to the supporting column, which in turn rests on the bed of the river. The inner plates, with the platform attached, have thus been lifted a distance equal to the travel of the piston; this being 18 inches., coincides with the pitch of the holes in both sets of plates, and these are now exactly opposite each other. Another suspension pin is then placed in one of the holes, the pressure in the cylinder is released, enabling the first pin to be withdrawn and leaving the platform suspended on the second, while the crosshead is free to descend and take hold of the holes of the next pitch and to repeat the operation, this being repeated until the platform has been raised as far as desired. To lower the platform this action is simply reversed.

In order to float the platform from one pier to another, it is first lowered down by the hydraulic gear sufficiently to catch the tide two hours before high water. Ropes and chains are attached from one side to the piers of the old bridge (60 feet centers from the new,) and to three heavy anchors on the other side. These attachments are made sufficiently in advance of the platform to allow it to be drawn to the next point of operation. The steam crane is then applied as a winch, and the platform advanced to the position of the next pier. The necessary capstans, steam and hand winches, and fair leads are applied to bring the platform as near as possible to its true position for founding a pier. The supporting columns or legs are now lowered down by the hydraulic gear until they reach the bed of the river, and then the platform is raised up about 2 feet so as to be clear of the action of the tides. The valves in the bottom of the main tanks are then opened, allowing the water to pass freely into the tanks, and thereby removing any tendency to float at high stream tides. The platform having now become stationary, the work of putting down the piers is proceeded with. The centers are carefully set off by the engineers, and vertical iron guides placed at the four sides of the well holes and bolted to the top and bottom of the tanks in order to secure the sinking of the cylinder into its true position. Timber blocks are used above the taper portion of the foundation cylinder to maintain it in a perfectly vertical position, and at the same time to allow it to slide down as freely as possible. The foundation cylinders are rivetted together on shore and conveyed in convenient lengths by cargo boats to the platform. The various rings are lifted out of the boat by the 10-ton crane on the platform and placed inside the well-holes. A line of rails is laid on the platform so that the crane can be easily shifted from one well-hole to the other. The first ring is formed of $\frac{3}{4}$ inch wrought-iron plate, is 23 feet in diameter, and 13 feet 4 inches deep, having T iron stiffening bars outside; above this is the taper 7 feet deep, and then the upper portion 16 feet 6 inches in diameter. (See Fig. 4.) Each

ring as it is lowered into the well-hole by the crane is bolted by an internal flange to the preceeding one. These rings are lowered down through the well-holes by hydraulic jacks specially designed for the purpose by Mr. Arrol, and shown in Figs. 8 and 9. These lowering jacks each consist of a cylinder, piston, and hollow trunk, and are supported across the corners of the well-holes by two 14 inch square pitch-pine logs. Through the hollow trunk are passed a series of steel links bolted together in single and double lengths alternately, a cotter hole being former in each link at a pitch of 10 inches. On the top of the hydraulic cylinder is fixed a bow through which the links are passed, while they are also securely bolted to the lower portion of the foundation cylinder. The links are suspended by means of a steel cotter 10 inches by 3 inches by ¾ inch resting on the bow of the jack.

The action in lowering is as follows: Suppose the combined piston and trunk to be raised almost to the top of its stroke by the admission of water through the cock at A, Figs. 8 and 9. A steel cotter is then inserted through one of the holes of the links and across the top of the trunk, water is again admitted, the links are slightly raised and with them the foundation cylinder, thus enabling the top cotter resting on the bow to be withdrawn and inserted in the next hole higher up. The water is then allowed to escape, and the piston descending carries with it the links and the foundation cylinder until the cotter again rests on the bow of the hydraulic cylinder. The lower cotter is now withdrawn and inserted in the first hole higher up, when the same processes are again gone through, gradually lowering the cylinder until the bed of the river is reached. The number of hydraulic jacks used for the placing of a cylinder is four. The pumps for supplying the water under pressure were made by Messrs. Fullerton, Hodcart, & Co., of Paisley.

As each portion of the cylinder is bolted together a ring of brickwork about 18 inches thick is carried up inside resting on a bracket at the top of the tapered part. This brickwork assists the cylinder in sinking by giving it increased weight, it also serves to maintain the cylinder in its proper form. The cylinders are pressed down to their proper depth by cast iron weights, each weighing ½ ton, these being placed on top of the brick lining. While the cylinder with its added weight of brickwork and temporary weight of cast iron is being pressed into the bed of the river, the material is excavated from the inside, a steel digger of the Milroy pattern being used. This is of the same type as that used in the construction of the Clyde Viaduct. A hydraulic digger was also tried in the hard clay and stones formation. The strata penetrated by the cylinders is chiefly silty sand with occasional beds of gravel and boulder stones and beds of clay, the weight required to press the cylinder down through some of these latter being as much as 400 tons. In some cases the cylinders were sunk as far as 3 feet into the red sandstond rock.

In the excavation of the silty sand it was found that the digger lost a considerable quantity of the material while being hoisted up through the water. This led to trials being made with several kinds of pumps in order to raise it. The best results, however, were obtained from a 12-inch centrifugal pump. The suction connections of this pump were arranged as follows: Two flexible hose-pipes, each six inches in diameter and 20 feet in length, were placed in the bottom of the cylinder, one of the ends of each were brought together and joined into one 12-inch pipe leading to the pump on the platform. A diver was then sent down, who manipulated the suction pipe to the work, only one of the pipes, however, being used by him at a time for the sand, the other running up clean water and thus preventing the pump getting choked. As much as 40 cubic yards have been pumped up in an hour, giving a subsidence of over 2 feet on the cylinder. When the tide was too low for pumping the digger was used. In strata of a clayey nature where the material would not pass up through the pumps, the two flexible hose-pipes were taken off and the water pumped down as far as possible, giving additional pressure on the bottom owing to the difference of level of the water. In this manner as much as 11 feet length of cylinder were sunk in thirty minutes, and the material afterwards taken out by the digger.

The material excavated from the inside of the cylinders is placed round the outside of them. The portion of the pier formed by these cylinders finishes at low-water level. While each section of the cylinder is being sunk, temporary caissons (see Fig. 1) are bolted to the upper flange in order to keep the weights in their proper position; to exclude the silt from the river, and also to assist in securing the descent of the cylinders in a truly vertical position by the guides previously mentioned as bolted to the tanks. The cylinders having been sunk to their proper depth, and the interior cleaned out to the cutting edge, the concrete is then put in.

The gravel and cement are brought out to the platform by cargo steamers of a carrying capacity of 150 tons. The gravel is filled into tipping measure boxes, along with the necessary proportion of cement (six of gravel to one of cement), and lifted by the gearing of the boat on to the platform at a point above the cement mixer, which is one of Jamieson's patent, as shown at A, Fig. 3. The material is led into the hopper and watered from a rose fixed inside. For the water supply one of the supporting "legs" is utilized as a tank; this tank being filled from the river by one of Root's rotary pumps. The revolving casing of the mixer is square in section. The obvious effect of this section in revolution is to produce a more overlapping movement of the material than is obtained by the use of a cylinder. The material is also longer retained, getting as many as thirty turns before being delivered into the receiving boxes.

The motive power for this machine is obtained from a steam engine of eight-horse power attached to the machine framing. Twelve yards per hour has been the amount of work turned out by this machine, but when the tide was high and everything favorable, as much as 15 yards an hour was got. The receiving boxes are fitted with hinged hopper bottoms, so that when they are lowered down through the water into the cylinder and touch the material already placed, the catches are withdrawn and the concrete deposited. When the concrete comes up to the flange carrying the brickwork, the diver is sent down to have it all carefully packed underneath. The concreting is then continued up through the cylinder, finishing at the same level as the brickwork, viz., low-water level. While this operation of concreting the cylinder is going on, the other foundation cylinder is brought out from the shore and sunk into position in the manner already described. When both cylinders of a pier are sunk to their proper depth, the temporary caissons are removed, thus allowing the platform freedom to be shifted over to the next pier, this being easily accomplished, since, as has been already stated, the cylinders themselves are not carried higher than lower-water level. The platform having been removed the piers are tested with a load ranging from 500 tons on the 10-foot diameter cylinders up to 2438 tons on the cylinders of 23 feet diameter. The cylindrical shafts as sunk having been tested satisfactorily, the temporary caissons are replaced, and the brickwork carried up inside them and faced with blue vitrified Staffordshire bricks to withstand the action of the water. A connecting piece, shown at B, Fig. 4, 7 feet in depth, resting on cast-iron girders, and 18 inches above high-water level, forms along with the brick shafts, the base on which the superstructure is erected for carrying the four girders of the railway. These platforms have already sunk 50 pairs of cylindrical shafts, the total number to be sunk being 73. They range from 10 feet to 23 feet in diameter, the maximum length being 52 feet. To each of the platforms is allotted a squad of 20 men, and these are subdivided into a night and day shift. Of an adaptation of means to ends on the first principle of all true design (simplicity and directness) these platforms afford a good example. They have been found sufficient for carrying safely heavy cranes, men, machinery, and materials, while they have proved equally facile for removal from pier to pier. With them work can be carried on during all states of the the tide, while they have been found capable of standing the fiercest gales and of sinking the cylinders in their true position.—London *Engineering.*

Three Problems in River Physics.*

BY PROF. J. B. JOHNSON, WASHINGTON UNIVERSITY, ST. LOUIS, MO.

In the past five or six years, there has been a great deal of money spent upon, and study given to, many questions of a scientific nature pertaining to the improvment of our western rivers. Your attention is called to some conclusions that may be drawn from recent investigations on the three following problems:

I. The Transportation of Sediment and the Formation and Removal of Sand-bars.

II. The Flow of Water in Natural Channels.

III. The Relation of Levees to Great Floods, and to the Low Water Navigation of Rivers.

I. *The Transportation of Sediment and the Formation and Removal of Sand-bars.*

The solid matter carried by streams of variable discharge and cross-section, flowing over sandy beds, is at once the cause of, and remedy for, most of the obstructions to the navigation of such streams. A proper understanding of this subject is a prime requisite to an adequate conception of the conditions governing the flow of water in natural channels, the improvement of low water navigation, flood confinement, etc.

In all natural water courses, the material carried by the stream may be graded according to the method of its transportation, as.

First, That carried in continuous suspension.

Second, That carried in discontinuous suspension.

Third, That carried by rolling on the bottom.

Sediment in Continuous Suspension. This is composed of such finely divided particles of clay and mud that any slight disturbance of the water in a vertical direction is sufficient to prevent its deposition, and so it mostly remains in suspension until it reaches the sea. A large part of the sediment carried by the Mississippi River is of this class. It mostly comes from the western tributaries, more especially from the Missouri. If a quart of this water be placed in a glass jar, and set away, it requires some ten days for the water to become clear. Evidently, this kind of sediment does not form sand bars, neither can the engineer avail himself of it in building artificial banks in contraction works. It is therefore of no consequence to the river engineer. It is neither helpful nor harmful, and may be ignored.

Sediment in Discontinuous Suspension. This kind of sediment is composed of sand, more or less fine according to the velocity of the stream. It is the material of which sand bars are made, and it is also the material out of which the engineer builds his artificial em-

*Read at Phila. Meeting of the American Assoc. for the Advancement of Science Sept. 4, 1884.

bankments by the square mile behind his permeable dykes. It is constantly being picked up at one point and put down in another by the action of a law as unchangeable as the law of gravity. In the river's tireless efforts to attain a uniform flow it is constantly scouring out the engorged sections, and filling in the enlarged sections. For any given stage of water, the volume discharged at successive sections is the same, but since the sections do not have equivalent areas, the mean velocity at successive points is a constantly varying quantity. The river undertakes to overcome this inequality and so engages in an enormous carrying trade, which consists in cutting out the bottom where the section is less and the velocity more, carrying this sand to the first point below where the section is more and the velocity less, and there it is deposited. Evidently, if any given stage of water should continue long enough, this double action of scouring the small sections and filling the large ones would result in a nearly uniform flow, when such small particles as could be carried by the resulting velocity would be so carried in permanent suspensions, leaving a bed of tolerable permanent character, being only influenced by the matter rolling on the bottom. But here comes the trouble. No sooner has the river set to work to adjust itself to any given stage, than behold, the stage changes, and then it must go to work, cutting and filling at new points, and as the stage if ever changing, the river is ever beginning anew in its endless task.

It may not be clear why this change in stage should so disarrange matters. Let us see. The cause is the great variation in width. Take an actual case. At Plumb Point, on the Mississippi River, sixty miles above Memphis, the following extremes were found in 1879 on a reach eight miles in length.[1]

		Wide Section.	Narrow Section.
Surface width, in feet.	High water.	8840	1680
	Low "	7330	1375
Mean depth " "	High water.	23.9	60.7
	Low "	6.0	23.9
Area of section in sq. ft.,	High water.	280000	94500
	Low "	30220	68500
Mean velocity in ft. per sec.	High water.	3.67	10.1
	Low "	2.65	1.15
Fall per mile in feet.	High water.	0.26	1.75
	Low "	1.15	0.07

[1] From plate 7, p. 120 of same report.

Thus, at low water, the wide section had a mean velocity of 2.65 feet per second, while the narrow section had a mean velocity of only 1.15 feet per second. At a stage 26.6 feet above low water (which in the table here given is called "high water," although it is some eight feet below extreme high water) the conditions are reversed, for now the wide section has a mean velocity of 3.67 feet per second, while the narrow section has a mean velocity of 10.1 feet per second. Here the wide section was some eight miles above the narrow one. Evidently the river is cutting out the shoal and filling up the pool in low water, and cutting out the pool and filling on the succeeding shoal in high water, and in fact this is what is always observed to occur.

The amount of this local scour and fill on the Mississippi river is enormous. In the case above noted there was a total scour over the reach of 350,000,000 cubic feet or enough to cover one square mile to a depth of 11 feet. This occurred from Nov. 13. to Jan. 3. In many cases the rate of fill and scour, as well as the total amount, is much greater than this. It is not uncommon for the shoal places to be built up as much as from six to ten feet in time of high water, so that the bottom of the river is then higher than the surface of the water will be after this same fill has been cut out by the succeeding low water. In other words, the river bed is a succession of narrow, deep pools, alternating with wide shoals. The pools are in the bends, and the shoals are on the crossings. The shoals are like so many dams, fifty to seventy-five feet in height, stretching across the river bottom say every ten miles. In high water these wide dams are built several feet higher, and the narrow pools are dug several feet deeper. In time of low water the dams are scoured down several feet, and the material deposited in the succeeding pool. What is true on the Mississippi river on a large scale, is true of every stream flowing in a friable bed, on a corresponding scale. This sediment is, therefore, said to be in temporary or discontinuous suspension. It settles very quickly where a sample is caught in a vessel, and the amount carried by the river is only determined by taking samples at various depths. There is little of it near the surface, except when there is violent vertical agitation, as in "boils" and eddies. It is constantly and rapidly falling towards the bottom, and is only prevented from reaching it by the upward motion of the medium.

Material transported by rolling on the bottom. When the grains of sand are too large to be held in temporary suspension they may yet be moved along on the bottom from being unable to resist the force of the current. This motion is also mostly discontinuous inasmuch as the particle is pushed up the gentle slope of the upper side of a sand wave or reef, and dropped upon the abrupt down-stream side, there to remain until the reef has progressed so far as to again expose it to the action of the water on the up-stream side. The amount of material so transported is fairly represented by the size and rate of travel of the wave.[3] These sand waves, or reefs, may be as much as 8 to 15 feet high, extend from one-half to three-fourths the distance across the river, and move from 10 to 30 feet a day. They succeed each other at intervals of some 300 feet. The same action is seen by the roadside, on a small scale, after a shower. It obtains in all natural water courses, is found in both pool and shoal alike, but is most strongly developed on the shoals. It is largely instrumental in the formation and removal of sand bars, but is of little use to the engineer in building embankments. It is in this way, however, that the slow currents of a low stage may cut a channel through a wide and high bar.

Although the mean velocity may be small, the bottom velocity is relatively large on account of the shallow depth. The period of its action is also apt to be longer than that of flood stages. The amount of matter so transported is, however, small on the Mississippi river, compared to that carried in suspension. A knowledge of this action is mainly important as going to explain the regular changes that are observed to take place on the bottoms of cross-sections of rivers.[4]

II. *The Flow of Water in Natural Channels.*

It is now generally admitted that no formula, involving only the variable functions of slope and cross-section, can ever be used to give even approximate values of the mean velocity, across a given section, of a stream flowing in its natural or irregular channel. Farther than this, we are now forced to the conclusion, that no such formula can ever be used to give the continuous discharge of a single stream, at a given station, even though the actual observed mean velocities on that section, for one year be used in its derivation.

The common type of formula is

$$v = c\, r^m s^n$$

where

v = mean velocity across the section.
c = a constant coefficient, either general, or specially derived for each case.
r = hydraulic mean depth = $\frac{\text{area of section}}{\text{wetted perimeter}}$
s = slope = sin. of angle of inclination to the horizontal.
m and n are usually taken as $\frac{1}{2}$.

The Chezy formula, which is of this type is:

$$v = c\sqrt{rs}.$$

Most of the efforts made to adapt this formula to the flow of water in natural channels have been spent upon the coefficient c.

It is, however, no longer a question of coefficients or exponents. For regular and stable channels, like flumes, canals, or ponds controlled by fixed weirs, formulæ can readily be deduced that will give fair results, but in all natural channels, the cross-section, slope, and flow, are so irregular, and the bed so changeable, that the variables affecting the flow are not adequately represented by r and s, and hence, any formula based on these for the independent variables will surely fail.

A body of finite mass, moving under constantly varying accelerating and retarding forces, never has a velocity at a given point which is a function only of the forces acting at that point. Since the accelerating forces of a stream are due to the slope, and the retarding forces are due mainly to bed and banks, and since the conditions of slope, bed and banks are constantly changing in the progress of a given mass of water down stream, it follows that this mass is subject to constantly varying forces. The velocity of this mass at any section is therefore a function of the slope and bed for an indefinite distance above, and can never be predicted from the immediate conditions at the section.[5] Whether or not it can ever be predicted, within reasonable limits, is still a question, but some new light has recently been shed on this much mooted subject. If the conditions of slope, approach, cross-section, and discharge, should be always the same at the same stage of water, or for the same stage and same rate of rise or fall, then a cycle of observations on mean velocity might enable us to predict what the next cycle of mean velocities would be at that same section. But, as outlined above, in discussing silt movement, it is seen that, in streams of unstable *regime*, the bed is constantly shifting, and that the high ridges, or bars, that alternate with the pools, are constantly changing their height. If these ridges be conceived as weirs, and the stage of water in the intercepted pools be controlled by these weirs, which it is in medium and low stages, then the discharge in this pool may be discussed with some confidence and profit. If the section be located in the lower portion of the pool, so that the conditions of approach over the weir above be of little consequence, then the conditions affecting discharge are, the *effective head*, that is, the surface slope from the section to the weir below, and the *depth on the weir*. The origin, from which the stage should be measured, in this case, is the natural zero of hydraulic activity, viz.: the horizontal plane passing through the crest of the weir. When so taken, a very simple relation is found to exist between *stage* and *mean velocity*, inasmuch as the latter is a linear function of the former.[6] If this relation be determined by observations at that section, then it may safely be used *so long as the weir*

[1] See Report of Miss. Riv. Commission for 1881, p. 69.

[2] See Report of Chief of Engrs. U. S. A. for 1879, Vol. III, p. 1963; also Reports of Miss. Riv. Com. for 1881 and 1882.

[3] For an article on "Silt movement by the Mississippi," by Robt. E. McMath, see Journal of the Association of Engineering Societies, v. 1, p. 266.

[5] The problem is similar to the instantaneous relation existing between the pressure on the piston of a crank engine, the resistance to motion, and the velocity of the fly wheel. No one would for a moment suppose that a formula could be derived that would express this relation for any given instant, and yet this is exactly what has been attempted on streams for the last one hundred years.

[6] The locus is probably an hyperbola, which becomes practically a straight line for all stages above a few feet. See paper by R. E. McMath before Am. Soc. of Civil Engineers, v. 11, No. 239.

condition remains fixed. When this changes, by scour or fill of the bar, then the origin of the locus changes with the change in origin for stage. But the weir condition could be made the subject of observations, and the locus of the curve of mean velocity and stage so adjusted as still to indicate the mean velocity for this locality, provided the section on weir, or bar, should remain, the section controlling, or limiting, the discharge. In high stages, the region over the weir becomes itself the comparatively stagnant pool, and the controlling or limiting section is in the deep and narrow bend below. The low slope is now over the shoal, and the steep slope in the deep pool. This slope is used to generate the accelerated velocity through the engorged section. The condition of a slack pool, retained by a submerged horizontal weir, now no longer obtains, and the narrow, deep reach around the bend with high slope, is similar to an engorgement by lateral contraction. This is a very different problem, evidently, from what we had at a lower stage when the weir section was the limiting one, and a discussion of this state of affairs offers greater difficulties than the other. As a striking example of this change of location of the engorged sections see the table given above in discussing the movement of sediment. Thus, in low water, the deep section had an area of two or three times that of the shoal section, and a slope of one-sixteenth as great, while at high stage, the deep section had an area of only thirty-six hundredths of that of the shoal section, but its slope was seven times as great.

The object of this presentation is not to discuss or derive formulæ, but to call attention to some of the heretofore neglected functions of the problem. These functions are seen to be so various, and apparently lawless in their nature, that it is highly improbable that we shall ever be able to obtain any formula of much value. A service has been rendered, however, when the impossibility of a successful solution on the lines of investigation so long pursued has been pointed out. Also, when the real determining causes effecting flow are properly conceived and investigated, rational and valuable formulæ may be obtained for exceptional cases of stable conditions.

III. The relation of Levees to Great Floods and to the Low-water Navigation of Rivers, as illustrated by the Mississippi River.

That levees may be built which will confine the greatest flood on the Mississippi River, without danger of their giving way, may be admitted. The question is, What shall be their size and location?

The location of a levee is determined by two considerations in favor of putting it as near the bank as possible, and by two others in favor of putting it away as far as possible. The arguments in favor of putting the levee near the bank are:

First.—The land near the bank is generally higher than anywhere else. There is generally a well-defined slope away from the river, and therefore a levee here, to confine a given flood plane, will have the minimum height and cost.

Second. The land near the river bank is always most valuable for cultivation on account of its being higher, and therefore the protection of this narrow strip is the chief cause for leveeing the river at all.

The arguments in favor of putting the levee at a distance from the river are:

First, so that it will not soon fall into the river from caving banks, and *second*, so that the facilities for flood discharge may be greater, and therefore, the flood stage and necessary height of levee less. This latter argument is so generally advanced that it is deserving of mention, but I will try to show that it is more visionary than real. The force of the other aguments above stated is evident, and they need no further discussion.

The height required for levees in a certain locality is a very complicated problem, and unfortunately for the lower Mississippi river it is a problem on which we have no direct evidence. By having no direct evidence, I mean that as there is no point on the river below Cairo where the whole of a great flood has ever been confined between levees, so there is no argument from experience.

In this dilemma we are forced to fall back upon theoretical considerations.

For the past three years, 1882, '3 and '4, we have had great floods on the Ohio and Lower Mississippi rivers, and a great deal of data has been obtained, such as we have never before possessed. The first installment of this flood data may be found in the Report of the Mississippi River Commission for 1883.[7]

The overflow water of a great flood loses itself out over the west bank of the river from Cairo to Memphis, passes down through the St. Francis swamp, and is forced back to the river again by the high bluffs at Helena. It then overflows the east bank, passes down through the Yazoo bottoms, and is again forced back to the river by the bluffs at Vicksburg. It then once more crosses the channel and escapes over the west bank to return no more, but to find its way to the gulf through the Tensas and Atchafalaya river regions.[8]

Notwithstanding the river has been leveed almost from Cairo to the Gulf, and in the lower parts of the valley these levees have been carefully maintained and gradually enlarged, yet in time of a great flood the surplus water seems quite oblivious of such frail barriers, and always goes over and through them very much as though it were quite unconscious of their presence. And every time the levees are destroyed the people seem as much astonished as though that were the first time such a calamity had ever befallen them. The trouble is that due weight has not hitherto been given to the enormous quantity of water passing outside the channel. Before the flood of 1882 no more approximate determination of the amount of such water had ever been made, and no one suspected it to be so large. From the observations taken on that flood, which was the largest on record, we find that on some zones, or belts, there was about as much water passing outside the channel as there was in the channel. The total maximum discharged in that flood was some 2,000,000 cubic feet per second, while for a hundred miles (by river) at and above Lake Providence, and for another hundred in the vicinity of New Orleans, the discharge in the channel, with overflowing banks, was but 1,000,000 cubic feet per second. The other million was finding its way to the gulf through the swamps. This is a very startling fact. It means that if we propose to completely confine the waters of a large flood between levees, we must, in places, carry twice as much water as the present channel can take. At all points below Cairo, it is now pretty well known how much more water would have passed in a confined channel, than did so pass in the flood of 1882. With such facts as a basis for estimates, engineers still differ very widely as to the necessary height the levees must have to confine these additional volumes. Some engineers affirm that the levees need be but little, if any, higher than they now are, while others insist that in places they will have to be from ten to twelve feet higher than they now are. The whole question turns on whether or not the bed of the river will scour out when all the water in confined to the channel. The popular conception, as well as the expressed opinion of most writers on the subject, is to the effect that a confining of the waters to one channel will increase the velocity of the stream (which everybody admits), that this increased velocity will give increased scour (which everybody admits, in a sense) and that this increased scour will result in a general lowering of the bed (which must be denied.)

In other words, there are two schools of engineers, the concentration school, and the equalization school. The former affirms the beneficial results of an increased volume at high stage; the latter not only denies any beneficial results but affirms that actual harm would ensue. Again, the question turns on the methods of transporting sediment. The concentration school argue as though all sediment were of the continuous type, and when once taken up it would be carried to the sea, provided all the water remained in the channel. But they say, in effect, that in case of a flow over the bank, while the water pauses to consider whether it shall go over the bank or remain in the channel, the sediment escapes from its grasp and settles to the bottom. On the contrary, we know, that when two forces, at right angles to each other, act on a moving particle, it moves over a path which is a resultant of the two forces, and so moves faster than if either force acted alone. Therefore, instead of the water being checked by the escape over the bank it is really accelerated. Again, the more the energy of a river is increased by increasing the stage the more unequal becomes the difference in area of successive sections in wide and narrow places, and at high stage the narrow and deep places are always the engorged sections. If the energy of the river be increased at this stage it simply scours out the deep places deeper, and drops this matter on the succeeding wide shoal. That is, any influence towards a temporary adjustments of the river's bed to a high water discharge is an influence which is adding to the heights of all the sand bars on the river. The greater the stage, the higher the bars and the deeper the pools become; and so far is this from facilitating the discharge, that, in the language of the Secretary of the Mississippi River Commission, "the effect of an approaching flood is to impede its own discharge and the impediment outlasts the flood." An example of this action is found in the flood of 1858 at Columbus, Ky., where the river was leveed. The discharge of the river exceeded 1,100,000 cubic feet per second, four times for December to June. The stages at which the river discharged this amount were: 29.5 feet, 32.5 feet, 33.5 feet, and 35.0 feet on a rising stage, and 31.6 feet, 34.7 feet, 35.9 feet and 36.9 feet on a falling stage.

If the successive differences between rising and falling stages at which the discharge was 1,100,000 cubic feet, be taken out for each rise, we have, 2.1 feet, 2.2 feet, 2.4 feet and 1.9 feet, as the legitimate effect of the change from a rising to a falling condition.

If, however, we compare the first and last rising stages when the discharge was 1,100,000 cubic feet, we find that in June it required a a stage 5.5 feet higher to discharge this water than it did the previous December. Making the same comparison on falling stage we find a difference of 5.3 feet. This was due to deterioration of channel caused by a building up of the bars or weirs, by a sufficient amount to raise the stage 5.5 feet in order to discharge the same amount

It is highly probable that the two high waters of 1882 and 1883, in the Ohio River worked such detriment to the channel that the flood of 1884 was raised several feet higher than it would have been had the same amount of water passed in 1882.

It would seem, therefore, that in the rivers present condition, there is no evidence that a confined flood will scour out its bed so as to facilitate the discharge, and there is considerable evidence against it. If the river flowed

[7] Supplemented in the Report of 1884, by several reports on the observed volume of the overflow water in the flood of 1882, including one by the writer on the Flood Discharge through the Yazoo bottoms.

[8] See paper by the writer on "Great Floods on the Lower Mississippi," in Journal of the Association of Engineering Societies, v. 2, p. 115.

between straight, parallel banks, such as Capt. Eads has constructed at the mouth of the river, then there could be no such thing as discontinuous transportation of sediment, and hence no alternate scour and fill. Then concentration of volume would be beneficial, and would ultimately lower the river bed. But this condition of things can never be reached on the Mississippi river, and hence the concentration of flood volume will ever be harmful rather than helpful.

It follows from this, that if an additional quantity of water is confined to the channel in time of flood, we must provide accommdation for it at the surface rather than at the bottom of the river. If this point be settled, it is not difficult to approximate to the new stage to pass the new volume. There are many stations on the river below Cairo where discharge observations have been conducted for one or more years. If, for one ot these sections, we plot stage and discharge, we get a curve showing the relation of the two from low water to say 50 feet above. If the levees be near the banks, which they usually are, and they be high enough to confine the flood, the conditions of flow will not be materially changed as the water gets in above the bank. If, now, we know what the additional quantity will be to confine it all, we could *simply extend the discharge curve* until we reach the proper volume, and then read off the corresponding stage. The only uncertainties here are in the curve itself, which may not rigidly apply for another year at the same locality, and in its extension. These uncertainties may have a maximum value of several feet, and yet it is the only argument we can use, and it will give approximate results, which are more likely to be too small than too large. If the heights of levee necessary to confine such a flood as that of 1882 be found in this way, and the additional cost estimated, it makes an item of over $50,000,000, to complete the levee system from Cairo to the Gulf. It is questionable if such levees ever will be built.[9]

In regard to putting the levees farther from the banks, the two main objections have already been mentioned. There would be also little advantage from increased facility of discharge. The ground would have to be kept clear of all timber, weeds, and undergrowth, or else it would offer very poor opportunities for discharge. This could hardly be done. The water flowing across a neck, also, does more to hinder than to help the flow around the bend, by lessening the volume in the channel.

There is another expedient which has been advocated, which appears to be practicable, but for which there are not yet sufficient surveys to determine. It consists in having ordinary sized levees, such as are now built, which will confine the ordinary floods, with waste weirs at such points as offer the best facilities of discharge through the swamps, to let off the surplus waters without detriment to the levees and with the least possible damage to the lands. There are a great many natural outlets from the river back to the main drainage channels of the bottoms, which could be utilized in this way. This sort of outlet however, is more like the spilling of the water over the bank, than like a crevasse in the levee. These weirs would have to be miles in extent so that the depth of overflow need not be more than two feet. This arrangement has been adopted on the Rhone with very satisfactory results.[10]

The relation of levees to low water navigation has already been trenched upon above in showing the effect of increased stages at time of high water, in building up the bars. What is wanted is the removal of the bars, and for this purpose the low water energy should be increased and the high water effect diminished. In other words, the extremes should be brought nearer together which is all included in the term equalization of volume. Any influence, therefore, which forces these extremes farther apart is hurtful. Levees tend to make high water higher, and therefore, they are an injury to navigation.[11]

Evidently it would be of no advantage to navigation if the river bed were uniformly lowered a hundred feet, provided the same irregularities remained in the matter of pool and shoal.

If ever the river should be regulated in width so that the discontinuous movement of sediment becomes inappreciable, then the stage may be increased to advantage. It is highly improbable that this ever will be done, and therefore the building of levees on the banks of the Mississippi River will never prove an aid to low water navigation. On the contrary they will always tend to produce a certain amount of damage.

[9]The Miss. Riv. Com., in their report for 1883, estimate this cost at some $11,000,000, but Gen. C. B. Comstock, President of the Commission dissents from this view.

[10]See paper by the writer on "Protection of Lower Mississippi Valley from overflow" in Journal of the Association of Engineering Societies, v. 3, p. 169.

[11]See paper by Robt. E. McMath on "Levees—their Relation to River Physics," in Journal of the Association of Engineering Societies, v. 3, p. 43.

Public Buildings.

The following is a list of the public buildings in course of construction as well as those upon which work has not yet commenced:

Augusta, Me., post office, court house, etc., site purchased. No work dono.

Abingdon Va., court house, post office, etc., site purchased. No work done.

Aberden, Miss., court house, post office, etc., site purchased. No work done.

Auburn, N. Y., post office, court house, etc. site not purchased.

Baltimore, Md., post office and court house, etc. In progress.

Baltimore, Md., marine hospital. In progress.

Brooklyn, N. Y., post office, etc. In progress.

Buffalo, N. Y., custom house and post office. In progress.

Carson City, Nev., court house, post office, etc., site not purchased.

Clarksburg, W. Va., court house, post office, etc., site purchased. No work none.

Chicago, Ill., Appraiser's store. No work done.

Cairo, Ill., marine hospital. In progress.

Cincinnati, Ohio, custom house and post office. Nearly completed.

Charleston, S. C., custom house, wharf, etc. In progress.

Chatanooga, Tenn., court house, post office, etc. No site.

Concord, N. H., post office, court house, etc. In progress.

Columbus, Ohio, court house, post office, etc. In progress.

Council Bluffs, Iowa, post office, etc. In progress.

Dallas, Tex., court house, post office, etc. In progress.

Denver, Col., court house, post office, etc. In progress.

Des Moines, Iowa, court house and post office. Work not commenced.

Detroit, Mich., court house, post office, etc., site purchased. Work suspended.

Erie, Pa., court house, post office, etc. In progress.

Frankfort, Ky., court house, post office, etc. In progress.

Fort Scott, Kans., court house and post office, site donated. No work done.

Fort Wayne, Ind., court house, post office, etc. In progress.

Galveston, Tex., custom house, post office, etc., site purchased. No work done.

Greensborough, N. C., court house, post office, etc. In progress.

Hannibal, Mo., post office, etc. In progress.

Harrisonburg, Va., court house, post office, etc. In progress.

Jefferson City, Mo., court house, post office, etc. In progress.

Jackson, Miss., court house, post office, etc. In progress.

Jackson, Tenn., court house, post office, etc. In progress.

Keokuk, Iowa, court house, post office, etc., site purchased. No work done.

Kansas City, Mo., custom house and post office. In progress; nearly done.

Key West, Fla., court house, post office, etc. No work done.

Leavenworth, Kans., court house, post office, etc., site secured. No work done.

Louisville, Ky., court house, post office, etc., site secured. Work in progress.

Lynchburg, Va., court house, post office, etc. Work in progress.

La Crosse, Wis., court house, post office, etc., site secured. No work done.

Lexington, Ky., post office, etc., no site. No work done.

Manchester, N. H., post office, court house, etc., no site. No work done.

Macon, Ga., court house, post office, etc., site accepted. No work done.

Memphis, Tenn., custom house and post office. In progress; nearly done.

Marquette, Mich., court house, post office, etc., site secured. No work done.

Minneapolis, Minn., post office, etc., In progress.

Montpelier, Vt., post office, court house, etc., no site. No work done.

New Haven, Conn., custom house, etc. In progress.

New Albany, Ind., court house and post office, site secured. No work done.

Nebraska City, Nebr., court house, post office, etc., no site. No work done.

Oxford, Miss., court house, post office, etc. In progress.

Peoria, Ill., post office, court house, etc. In progress.

Pensacola, Fla., court house, post office, etc. In progress.

Port Townsend, Wash., custom house, post office, etc., no site. No work done.

Poughkeepsie, N. Y., post office, etc. In progress.

Pittsburg, Pa., court house and post office. In progress.

Quincy, Ill., post office, court house, etc. In progress.

Reading, Pa. post office, etc., no site. No work done.

Rochester, N. Y., court house, post office, etc. In progress.

Richmond, Va., custom house, etc., extension. No work done.

Scranton, Pa., post office, etc., site secured. No work done.

Sacramento, Cal., post office, etc., no site. No work done.

Shreveport, La., post office, court house, etc. In progress.

Springfield, Ohio, post office, etc., no site. No work done.

St. Joseph, Mo., post office, etc. In progress.

Syracuse, N. Y., post office, court house, etc. In progress.

Terre Haute, Ind., post office, etc. In progress.

Toledo, Ohio, custom house, etc. In progress.

Troy, N. Y., post office, court house, etc., no site. No work done.

Tyler, Tex., court house, post office, etc., site. No work done.

Williamsport, Pa., court house, post office, etc., site. No work done.

Wichita, Kans., post office, court house, etc., no site. No work done.

Waco, Tex., court house, post office, etc., site. No work done.

Winona, Minn., court house, post office, etc., no site. No work done.

Changing Gauge of Southern R. R'ds.—The work of changing the gauge of Southern railroads to the standard of 4 feet 8½ inches, is progressing steadily, if not rapidly. The change of the Mobile and Ohio ' will leave only two of the important lines running southward from the Ohio river of 5 feet gauge, and both of them are already making arrangements for the change to the standard gauge." The Louisville and Nashville will, it is said, make the change within the next few months, and the Cincinnati Southern system will follow suit as soon as an arrangement can be made with the trustees. The 5-foot gauge will then be practically limited to the seaboard Southern States, and will doubtless soon disappear. On the Atlantic Coast line the standard gauge now extends as far south as Wilmington, and the roads in that line from Wilmington to Charleston will soon be of the same gauge, while the Savannah, Florida and Western is ready to make the change at the same time with the connecting lines to the northward. The Richmond and Danville and its controlled lines are already preparing to abandon the old gauge, although no definite time has been stated. By the end of next year it is altogether probable that the Norfolk and Western and the East Tennessee, Virginia and Georgia will be the only important lines still retaining the 5-foot gauge, and their alteration to the standard will then become actually a matter of necessity, the time depending chiefly upon the financial condition of the companies.—*Savannah Morning News.*

R R Improvements.—A party of Manitoba engineers left St. Paul, July 20, for the purpose of altering the grade and lessening curves on the road between Darwin and Dassel, on the Breckenridge division.

Engineering News

AND

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THE proposition just made to the holders of West Shore bonds points the moral laid down in our editorial on the late financeering of that company, and its parallel scheme the South Penna.

The West Shore bondholders are to get one $1000 4 per cent. bond for each $2000 of the original 5 per cent. bonds and 8 per cent. of interest due and unpaid. The original inventors bought the W. S. bonds at about 80, or, $1600 for the two $1000 bonds, on these bonds $160 is due as interest, and at present market value a $1000 4 per cent. N. Y. Central debenture bond is worth $840; at this rate of figuring 58 per cent. of the original investment is wiped out, or lost to those who built their hopes on the brilliant future of this road as painted by its projectors.

The New York Central R. R. Co. will remove a rival, but it will own a parallel line for which it has little use in its every day business, and it has also depreciated the value of its own property in the struggle to obtain control. If bought experience is the best, all bondholders interested in the present deal should have a stock on hand sufficient to last them for a generation at least.

How Railways are Built.

Certain members of the South Penna. R. R. syndicate are very much excited over the proposed deal between Mr. Vanderbilt and Mr. Roberts, whereby peace, for a time at least, is to be assured between the two grand trunk lines they represent. The disgruntled capitalists say that they had good promise of $2.00 profit for every $1.00 invested, and object to a paltry 3 per cent. on their present investment as a substitute for these handsome prospective figures. They threaten to build another parallel line to the Pennsylvania with new men and new money.

Whether the future profits of a finished South Penna. Railway would or would not reach the figures here mentioned, is of little moment; but that the road was capitalized in such a manner as to make such returns possible, is a severe commentary upon our present methods of railroad financeering. Similar methods in a private business would be called dishonest, to put it mildly.

In the present case, as near as we can ascertain, a grand trunk line was to be built; a "construction company" is first formed with scarcely any paid-up capital and a figure head for a president; stocks and bonds are printed and the serious business of raising the money begins. A few capitalists are found who will loan this construction company $15,000,000, without any other responsibility or connection with the company, and for this cash loan they are to receive, in bonds and stock, $40,000,000, nearly three times the legitimate cost of the railroad and upon which they persuade investors they will pay interest and dividends.

If this arrangement was to hold for all time and the capitalists were alone to indefinitely carry the bonds and stocks, we would see no objection to this peculiar arrangement. But, when the proper time comes, the "dear public" is interested and the original investors unload at the highest figures of a fictitious market value; the bonds and stock at an inflated valuation find their way into the hands of the innocent and confiding, and when the bubble bursts, as sometime it must, these last are the victims and not the promoters, who simply add to their millions.

There is another side to this construction company business well worth investigating, and that is their relation to the men who actually do the work, the contractors. These last-named, hard-fisted men are first led by severe competition and close figuring on the part of the company to undertake the work at the lowest figure possible; they are made to give bonds for the faithful execution of their contract, to submit to a retained percentage of each estimate and to take such cash payments in return for labor and material as the construction company sees fit to pay them. It is not a question of how much work they can do, it is how much the company will permit them to do, and from month to month the company can shift these limits arbitrarily to suit its own ends. In a word the contractor is very securely bound on all sides; but who holds the construction company? What guarantes has the contractor that the money honestly earned will ever be paid him? With an average construction company he has no surety; and if any one doubts it let him consult the men who built the West Shore railway, and are now and have been vainly seeking settlement for claims of from $300,000 downward. The construction company is usually a purely paper corporation; it has little paid-up capital to meet any demands upon it, and the portion of the road constructed belongs to the holders of the bonds and stocks, even if a pile of dirt or a hole in a mountain had any value upon which the contractor could realize.

We believe the contractors on the South Penna. R. R. have been pretty well paid up, and do not doubt but what in this case they will get all that is theoretically due to them; but the practice is bad and the West Shore will serve as a sad example of its working.

Transferred to a private business, we would see little difference between the methods of a modern construction company and the peculiar financeering of a Ward or a Fish. No railroad should be permitted to be built until there was an honest demand for it that would furnish the capital required by legitimate means. The individual who would borrow money at 200 per cent. premium to build a costly house would be regarded either as a rogue or a fool, and why will not the same principle hold good when millions, and not thousands are to be secured for a proposed railway?

In this same issue we publish an article upon railway legislation in England; and, while we do not usually recommend the modeling of American practice upon English methods, we think that a little of the same close preliminary examination into the location, cause for being, and all the inner details of a railway scheme would be beneficial in our own country. We do not know that there is any legal limit to the capitalization of an English railway, but under the jealous scrutiny of a rival, and in the publicity given to the details of the project, any false valuation would furnish a powerful argument against the proposed road in the hand of a skillful adversary. Free railroads are theoretically a very good thing, but the public, who must ultimately pay for them, should be somehow assured that they are honestly built roads as well.

Shall England Build Our War-Ships?

The Engineer, of London, true to the trade instincts that led it to attack the late ministry for trying Worthington's pumps for the Suakim-Berber route and causes it to misspell the names of American manufacturers, when referring to them, gives its editorial page to the consideration of the Dolphin. After quoting, with much satisfaction, the following from the New York *Times*: "If we are to have good iron or steel ships we must have naval officers capable of making the drawings and specifications, or we must trust the work of designing as well as building to a competent builder, and where we are to find either the one or the other it is difficult to say," deduces, "their (the American's) proper course would be to pocket national pride, come to this country and order a man of war or two, send over to this country a few practical men who would watch the construction of this ship, and who would subsequently be able to form an opinion worth something as to whether American constructors and designers were or were not competent men. The ship herself would serve as a pattern, and would in any case *be worth a long price*."

Of course there is nothing in the above about the great advantage of not paying money to other nations as set forth as follows, in its issue of March 6, 1885, and reproduced in our number for March 21, when excited over the Worthington pump contract.

"But we should like to know why the contract was let to an American at all, and why a single penny of the money paid by the British tax-payer should be sent out of the country.

"The great advantage that Great Britain possesses over other nations in carrying on warfare, is that she has nothing to pay to foreigners for the greater portion of the munitions of war. Thus the money spent on ironclads is virtually taken out of one of John Bull's pockets to be put into another. But warfare will assume a totally different aspect if British taxes are to be employed to enrich the rival manufacturers of other countries while our own artisans lack bread."

While we extend to our esteemed British contemporary such thanks as his anticipation of the benefits accruing to his artisans, lacking bread, from *a long price*, may warrant, we remark that it was neither by ordering from England, sending practical men over there, nor by paying her *a long price* that 80 years ago we were able to whip the Algerian pirates into respect for the American flag, while England continued to basely pay them subsidies. Nor in the war of 1812 were our vessels, which managed to pound the conceit out of their vaunted navy, modelled on English practices, nor is there record of either a long or short price paid for any we had got at the end of the war, accepting those we paid for in iron. And it was our adhesion to the advice of Washington as given in his first inaugural "The

safety and interest of the people require that they should protect such manufacturers as tend to render them independent of others for essential, particularly for military supplies," reinforced by the words of Calhoun in 1816." "It is admitted by the most strenuous advocates on the other side that no country ought to be dependent on another for its means of defense—that at least our musket and bayonet, our cannon and ball, ought to be of domestic manufacture," that gave us at the end of the late "unpleasantness," the best armored fleet and most powerful guns in the world.

Neither the schooner the Baltimore nor California clipper were evolved from orders or practical men sent to England.

Our River, Lake and Coast marine is not understood to have been built up through *a long price* to British builders. Of the first, *The Engineer* is kind enough to speak highly, and no one who has crossed either the Irish or English channel, etc., and gone down our coast in one of the latter, doubts their superiority in efficiency and luxury.

If we were basing our plans and construction of bridges, locomotives, cars, tools, shelf-hardware and watches, on orders in England, does any one think we should now be selling such articles past England's doors and to her colonies, and the late distressing instance of *pumps* would not have wrung from our contemporary the above quoted sound maxims in national economy.

The Engineer wishes us to "order," not having the face to offer any of their ready made goods in which they could present a line of attractive bargains to buyers of the Mrs. Toodles class. There are the 3 out of 8 "first class" torpedo boats that were temporarily disabled within 24 hours after leaving Portland, "in spite of the weather being very favorable," according to *Engineering* of June 19th. As the French torpedo boats steamed 1,000 miles with this fleet without accident, it is possible we had better pay *a long price* to the people over the channel.

There is the Captain that should be had for salvage, and the vessel that lost its rudder "through structural weakness" at Bantry Bay, to say nothing of the ironclads that delayed the proceedings for four days at the same Bay, and at last had to be *towed* in by their consorts.

"Among the blind, the one-eyed is King," but a nation must be very blind to trust their defense to such vessels or pattern their navy after such incompetence.

With an eye for future long priced orders from others, if we can not be induced to fly in the face of the sound economic doctrines lined down by *The Engineer* as above, it says: "It would perhaps be as well that in future Americans should not boast too much of their powers of producing, let us say steel shafting for one thing." Nearly the first, if not the first steel shaft made in this country, broke, but before that, Mr. Roach had made over 190 iron shafts, many of which have gone into English steamers, *not one of which has broken in service.* Can *The Engineer* mention any English ship builder with as good a record?

Nor has any American built iron steamer ever been cuffed to pieces by the waves and reported "missing."

The ENGINEERING NEWS will not take cognisance of political attacks, but when foreigners attempt to take advantage of our family discords to the industrial loss of this country we propose to have a word to say, and if our esteemed cotemporary gives any more advice of the kind quoted, we will print a list of missing vessels, broken shafts, and weak backed steamers that will entirely spoil any trade advantage hoped to be secured by calling attention to any failure of ours that it may hear of.

ENGINEERING NEWS Three months for One Dollar,

Transporting Oil by Pipe-line.

At the meeting of June 5th, of the French Society of Civil Engineers, M. Paul Sage read a paper upon the Naptha Industry in the Caucasus. In the course of his remarks he called attention to the necessity for the construction of a pipe-line between Bakou and Batoum, with relays of pumps as practiced in America.

He speaks as follows of the work to be done by the pipe-line and pumps:—Supposing that the amount of naptha to be transported anually was 52,250,000 *pouds*, or 856,557 tons, and that the mean specific gravity was 0.867, (including in this quantity of oil the combustible required for fuel;) then with an iron pipe of 7½ in. inside diameter, tested to 100 atmospheres, the average working pressure should not exceed 50 atmospheres. The general formula in this case is:—

$$h = \left(1 + \Theta' + \Theta \frac{l}{d}\right) \frac{v^2}{2g}$$

in which:

h, in height of naptha for 50 atmospheres,

$$= \frac{10.33 \times 50}{0.867} = 595{,}70\ m = 1953.9 \text{ feet.}$$

Θ' is the coefficient of resistance at the entrance to the conduit, and this it is believed can be assumed as for water as equal to 0.505. Θ is the coefficient of friction of naptha against the sides of the pipe, which, with $d = 7\frac{1}{2}$ inches, would be, according to Darcy, 0.0226. But the results of experiments made upon the pipe-lines at Bakou make it appear that 0.035 is more correct, taking into consideration the differences in temperature resulting from the different elevations of the pipe-line at various points on its route.

The total volume of naptha to be transported would be 987,955 cubic metres; or taking 6,600 working hours, this would be 0.04158 cubic metres per second. Then

$$V = \frac{0.04158}{\frac{\pi . 0.19^2}{4}} = 1.467\ m = 4.81 \text{ feet per second.}$$

$g = 9.81$, taking the value for Paris which will answer in the present calculation, and $d = 0.19\ m$, or 7½ inches.

From the preceding formulæ it is possible to obtain the value of l, or the mean length between pumping stations, if we pay no heed to the profile of the ground and regard the algebraic sum of the ascents and descents as being theoretically nil. The l thus found is 34,387 metres, or 112, 789 feet, about 21⅓ miles.

The distance from Bakou to Batoum, measured on the road-bed of the railroad, is 894,000 metres or about 553 miles; dividing this distance by the mean already found gives the number of stations on the line as twenty-six. The power required for the machinery at one station, allowing an efficiency of 80 per cent. for the pumps, would be 358 horse power.

Lifting a Masonry Arch.

Les Annales des Travaux Publics for July, 1885, describes the lifting to a more elevated position of a masonry arch, having a span 32.8 feet and a rise of 4.26 feet.

The arch was 15 feet wide and at the key was 2.88 feet deep. A lining of plank was first put under the arch and then five centers made of wrought-iron, apparently. Under each end of the arch were then placed two bents of timber, 5.8 ft., apart and well braced in both directions. Each of these bents rested on two longitudinal timbers and between these sticks, midway between the centers, were located double wedges, and between each set of wedges and directly under the centers and their posts were lifting screws.

This arrangement having been carried out, the arch was cut at the springing lines with hammer and chisel, leaving, until all was ready three points of support on each side. When the weight of the arch, which weighed 180 tons, was thrown entirely upon the centers several cracks made their appearance and the crown sank about 1½ inches. At the first turn of the screws however it was found that the cracks showed no signs of further increase and the lifting was commenced with great uniformity. At each vertical inch of hoist the screws were stopped and the wedges tightly driven.

The total distance raised was 1.4 feet and this work was accomplished in 14 hours. During the lifting a further sinking of about ¾ inch took place, and the eight cracks extended from end to end of the arch. These cracks had a width of ¾ inch, but they were lost in the interior of the masonry without appearing on the extrados. These fissures were filled with a thin grout of one part Portland cement to one part of sand, and eight days were allowed for the setting of this cement before the centers were removed. When the arch rested on its new abutments a fresh hair crack appeared but without doing any further damage.

PERSONAL.

HARRY I. MILLER, son of John F. Miller of the Chicago, St. Louis & Pittsburg Road, has been appointed Chief Engineer of the Cincinnati, Lebanon & Northern Railway, with headquarters at Cincinnati.

PETER H. WATSON, ex-president of the Erie Railroad, died on Wednesday, July 22, at the Albert Hotel, in University-place, this city. He was born in Canada, sixty-eight years ago.

CHAUNCEY S. COLTON, the original projector of the Chicago, Burlington and Quincy Railroad, and for twenty years a member of the Board of Directors, died on the 27th ult. at his home in Galesburg, aged eighty-five years.

PROF. ROBERT H. THURSTON of the Stevens Institute, Hoboken, N. J., has accepted the post of professor of mechanical engineering, and director of Sibley college, in Cornell university, Ithaca, N. Y.

A force of five men, under CAPT. NELL detailed from the United States Geological Bureau, is encamped two miles from Rome Ga., engaged in prepairing a map for the geological survey, which will arrive in Rome in a few weeks.

SAMUEL W. MIFFLIN, one of the earliest of American civil engineers, died at his residence in Wayne, Delaware Co. Penna., on July 25, in the eighty-first year of his age. Mr. Mifflin comes of a Quaker family of Pennsylvania prominent even in colonial days. As a civil engineer he was long and favorably known, having been personally associated with the first lines built in his State. As we expect to shortly publish a detailed sketch of his professional life, we will defer any further mention at present.

CAPTAIN F. V. GREENE, of the United States Engineer Corps of the Army, who has been in charge of most of the paving done in Washington by the Government, sailed for Europe on the Aurania on the 24th inst. He has leave of absence for two months, at the end of which time he has been ordered to report at West Point, to be placed in charge of the Department of Practical Engineering. Captain Greene has become an eminent expert in city pavements. While abroad he will visit London, Paris and Berlin to examine and report on the condition of asphalt pavements and processes for A. L. Barber, of Washington, of asphalt pavement fame. Captain Greene has already visited New Orleans, St. Louis and Chicago to observe the effect of different climates on asphalt. There are more miles of such paving in Washington than in any other city in the world.

Railroad Legislation in England.

Written for ENGINEERING NEWS,

BY EDWARD E. B. TRATMAN.

Railroad legislation in England is, and always has been a long and tedious process, being almost as formidable a proceeding now as when Stephenson endeavored to convince less far seeing minds of the utility and advantages of railroads, over which people would be conveyed at the furious speed of ten, or even fifteen, miles an hour. The country already has a complete system of main lines, and these are naturally cautious of interference with each other's territory, and it is therefore by private parties principally that new lines are now promoted. Taken as a whole the proceedings are fair and impartial, politics do not enter into the question at all, and the strong opposition from existing roads interfered with, competing schemes, landowners, and other interested parties, usually succeeds in bringing out the weak and faulty points in any project; while Parliament is, as a rule, averse to authorizing a line the necessity for which, as well as whose good faith, is not fully sustained under the ordeal. It is Practically useless to put dead heads as directors in the Bill, to make out a cooked estimate, or bogus financial statements, or to make similar attemps to bolster up a lame scheme, since the engineers, lawyers and others of the opposition thrash the whole affair out as to the necessity, competition, operation, cost and other matters in detail, and then parade before the Committee anything disadvantageous which they may discover; so that at the present time engineers and others have to tax their energies to the utmost in order to obtain the necessary Act for their project; a natural consequence of which is that the leading men in the engineering and legal professions are much sought after by promoters, and both parties—but especially the latter—make as a rule a very good thing out of their Parliamentary practice.

England is now so well provided with iron roads that the construction of trunk lines is almost a thing of the past, and the majority of new lines which are now promoted are extensions and branches to shorten through routes, to afford additional accommodation, or to tap the more rural districts. Owing to the vast network of existing lines which spreads over the length and breadth of the country, it is almost impossible to lay out a line which does not interfere is any way with some railroad or other, and this interference becomes an important item in the consideration of the route to be adopted, so as to avoid any unnecessary crossing or competition, as existing lines are very sensitive, and will make a bitter opposition to any scheme which proposes to alter their levels or works in the slightest degree, while such opposition from existing companies is so powerful that it is wise to avoid it wherever possible. This consideration therefore, and the requirements of local landowners, fixes in a great measure the general route of the line, while the ordnance maps are so complete and extensive, and bear so much information, that with their aid and an inspection of general route of the proposed road, the engineer can usually determine the center line pretty definitely, so that little or no preliminary surveying or location is necessary, except in the case of long and important lines; many minor lines are laid out for Parliamentary purposes entirely by the ordnance maps. When the center line is approved by the promoters, it is laid down on an ordnance map of the 6 inches or 25.344 inches to one mile scale, together with the "limits of deviation;" these are imaginary lines parallel to the center line and usually 100 yards on each side of it, but are contracted however through towns, and sometimes also to avoid cutting into valuable property which would result in opposition from the owners, etc. The legal distance for such limits is 100 yards on each side of the center line in open country, and 10 yards on each side in towns; the distance is, however, occasionally put at more than 100 yards, but in such cases they are not properly limits of deviation, since the center line cannot be moved beyond the prescribed limit; this proceeding, however, has the effect of obtaining powers of compulsory purchase over the land, and is therefore resorted to when extra ground is required for stations or other purposes. Trial levels are now taken over rough or bad ground, so that several sections may be plotted, and the most suitable position adopted for the center line.

The map, or a mounted tracing of it, is now taken into the field and corrected, new houses, roads, etc., surveyed in, and all other alterations made within the limits of deviation, errors beyond these limits being of no consequence, and in fact very little is shown beyond them, fences etc., are, however, continued just beyond them to show their continuity. The scale of the plan must not be less than 4 inches to 1 mile, and if less than 400 feet to 1 inch, an enlarged plan on that scale, or a larger, must be given of every building, courtyard and premises situated within the "limits." In Scotland and Ireland, and for some unimportant lines in England, the 6 inches to 1 mile scale is adopted but for the majority of lines the usual scale is the large ordnance of 25.344 inches to 1 mile, while for lines in the city of London, the 5 feet to a mile ordnance scale is principally used. Everything of a permanent character has to be shown, even down to ash-bins and fowl-runs if built into the ground, therefore for a line running through any considerable amount of buildings the 25 inch scale (as it is usually termed) is by no means too large. When the plan is completed, correct tracings are made in lengths of about two feet, usually about a mile on a sheet, with a cut line at each end to show how it connects to the next sheet; the center line is marked by a thick black line with every furlong and mile numbered; the beginning and termination of curves marked, and their radii stated where less than a mile; and the names of counties, parishes and townships, etc., written on. The levels are then taken along the line, and cross-sections of all roads or railroads which are to be interfered with have to be shown for 200 yards on each side of the center line. The section is plotted to the same horizontal scale as the plan, and for the 25 inch map has usually a vertical scale of 40, 50, or 60 feet to the inch. This section is divided up into the same lengths as the plan and is generally printed on the same sheet, the plan above, and section below, with cross-sections between, which is a very convenient arrangement for reference: on the section the level of top of rails is shown by a thick black line, a datum is given at a certain depth below a stated bench mark, furlongs and miles are marked, the height at each end of every gradient and the inclination of the same is shown, the greatest depth of every cutting and height of every embankment is also marked, as well as the vertical distance from rail to surface at any road, river, canal or railroad crossed by the proposed line, and the height and span of the arch at such points must also be stated. Tunnels are marked on the plan by a dotted line and on the section are shown the intended height, the length in yards is stated; viaducts are also shown on the section: where a junction is to be made with an existing line of railroad, a plan and section of such line must be given for a distance of 800 yards on each side of the point of junction. Cross-sections are only required of roads whose levels are to be altered and the amount of alteration must be stated, the inclination of present and altered approaches being also shown on the cross-section.

The plans are now lithographed, forming a book with pages about 30 inches by 18 inches, which are called the "deposited plans" from the fact of their being deposited in the office of the Houses of Parliament. Each house, road, field, and other property is given a number on the plans, and a book is prepared, called the "book of reference," giving the number, description, owner, occupier and lessee of such property. Besides the deposited plans and book of reference, an estimate of the cost has to be prepared to a standard form (See Appendix), and in certain copies of the deposited plans, an ordnance map of the 1 inch to a mile scale with the proposed line marked on in red must be bound up; these copies are for the Clerks of the Parliament. Copies of the plans, and reference book, must be deposited on or before November 30th, and the estimate on or before December 31st, with the clerks of both Houses of Parliament, and the clerk of each county in which the line is situated, each parish clerk also has a copy of so much of the plans and reference book as affects his parish; other copies have to be deposited with certain other parties, and in most cases the important landowners, local authorities, the engineer and manager of existing lines affected, and other parties interested are also supplied with copies. Previously to the 30th of November a notice of application to Parliament for permission to construct the line, containing a full description of the route of the same, defining its termini and giving the names of all counties, parishes, etc., roads altered or stopped up, and all such information must be published for one day in each of three consecutive weeks in some newspaper of each county in which the line is to be situated, as well as in the official "Gazette," and a London paper (Dublin for Ireland; and Edinburgh for Scotland). Notices of application must also be served on landowners, and others affected by the proposed line, on or before December 15th. After a week or two during which the various plans and documents are arranged, they are opened to inspection at the Private Bill Office, in the House of Parliament and for certain charges can be traced or copied in a room provided for the purpose, usually one of the committee rooms; and engineers of rival or competing lines can then obtain copies to compare with their own, and look out for their rivals errors.

When the engineer, aided by the solicitor and parliamentary agent of his clients, has got all his plans, etc., safely deposited, and the deposit money paid (a certain percentage on the estimate), he begins to prepare for his opposition to rival lines, or others which he may be retained to oppose. For this purpose he gets a copy of plans, reference-book, and estimate if possible; or if not, gets them traced and copied at the Private Bill office or County clerk's office; and sends men into the field to detect errors, which are then carefully described and made as much of as possible by the solicitor in a memorial to the Standing Order Committee, which memorial is lodged on January 9th, if the bill is numbered below 100, 16th of January if between 100 and 200, and 21st of January if above 200. Errors on plan, or in reference book, wrong numbers, numbers not corresponding in the same; omitting to give landowners notice, and similar cases form pleas for non-compliance with standing-orders. The Examiners for Standing Orders sit in February and consider all the memorials and petitions for and against each bill, in order to decide whether the rules embodied in the Standing-Orders (certain standard rules to be complied with in every case, or only dispensed with by authority of the examiner), have been duly complied with, and reject or pass such bill, those rejected being *hors-de-combat* for that session, appeal may, however, be made for re-examination, but this is very rarely granted; in doubtful cases the bill is submitted to the Standing-Order Committee, who give a final decision. From the Exam-

APPENDIX:

[Form of Parliamentary Estimate.]

IN PARLIAMENT—SESSION 1885.

BRISTOL AND CLIFTON RAILWAY.

ESTIMATE OF EXPENSE.

	Miles.	Furlongs	Chains	Singl. or Double		
Length of Line	15	4	0	Double		
	Cubic Yards	price per Yd		£	s	d
Earthworks: Cuttings—Rock	10,000	2 s.	1,000 0 0			
Soft Soil	326,000	10 d.	13,583 6 8			
Roads	8,800	1 s.	440 0 0			
Total	344,800		15,023 6 8	15,023	6	8
Embankments, including roads, 37,500 cubic yards @ 1s				1,875	0	0
Bridges—Public Roads, Number—10				20,000	0	0
Accommodation Bridges and Works				5,540	0	0
Tunnels				25,353	0	0
Viaducts						
Culverts and Drains				4,000	0	0
Metalling of Roads and Level Crossings				1,500	0	0
Gatekeepers Houses at Level Crossings						
Permanent Way, including Fencing: Miles: 15 Fur. 4 Chains. 0 Cost per Mile, at £7,500—0—0				116,250	0	0
Permanent way for Sidings, and cost of Junctions				5,000	0	0
Stations and Signals				20,000	0	0
				214,541	6	8
Contingencies, 10 per cent.				21,454	13	4
				235,996	0	0
Land and Buildings, Acres. 180 Roods. 0 Poles. 0				164,004	0	0
Total				£400,000	0	0

EDWARD E. R. TRATMAN,
Engineer.

iner for Standing Orders of the House of Commons, the bill is carried to a similar official of the House of Lords, and if passed by both is then ready for the Select Committees.

Each committee is composed of five member, viz.—a chairman and four others, and has a certain group of bills to consider. They usually commence their operations about March (all bills going first before the Commons committee;) and sit from 12 o'clock noon, till 4 P. M. each week day except Saturday. The case is held in one of the committee rooms in the "House," the committee sitting behind a curved table, and the engineers, lawyers, councillors, solicitors, parliamentary agents, short hand writers, clerks, etc., sitting within a bar across the room, on the other side of which are the witnesses to be called, parties interested in the line, and the general public. Various witnesses are examined for, and against the bill by the respective counsel, who also make long and exhaustive speeches: when the case for the bill is concluded the case for the opposition commences, after which the chief counsel of each party make their final speeches, and after a (usually) brief deliberation the committee give it as their decision that the bill is, or is not, passed. Cases last from a few days to weeks, or even months, according to the length and importance of the line. If the bill is passed by the Commons, it is carried before the Lords and the same performance gone through again, but if rejected by the Commons it is thrown out altogether, for that year's session at any rate. During these operations the bill, which is a printed document setting forth the route of the line, names of promoters, amount of capital and other particulars; has had to be introduced into, and read three times before, each House, but unless the line is particularly important or noteworthy this is usually a mere matter of form. Should the bill be duly passed by the Houses and their committees it is ready for the Queen's assent; upon receiving which it ceases to be a bill and becomes an Act of Parliament, in which form it is very different from its original, alterations having probably been made by each committee and stipulated requirements, as for accommodation works, etc., inserted, so that it is much more lengthy and contains more details than the original draft. Summarizing these various stages:—the line is projected probably in the summer or autumn; plans and reference book deposited, and notices published by November 30th; estimate deposited December 31st; memorials and petitions lodged 9th, 16th or 21st of January, the case goes before the Examiner for Standing Orders in February or March; and reaches the Committees sometime between March and August; the Queen's assent is obtained in August or September, and there is the Act of Parliament authorizing certain parties to build and maintain the A, B, and C. Ry. The Act names the directors and promoters, states the capital and all financial details, nature of works, rates of tolls and fares, accommodations and all particulars, and when the line is a branch from an existing road, a working agreement is frequently appended, stating the terms upon which the main company is to work the traffic on the new line.

The term for the completion of the work is usually put at five years (sometimes three;) if the line is not completed in that time, an Act for an extension of time may be obtained, or if neglected and no such Act obtained, the company forfeits their interest in the work, as also the deposit money. An Act for abandonment can be obtained which provides for the return of this money.

Preparations may now be made for letting the contract and starting the work.

Street Cleansing and Maintenance.

A mass of useful information about roadway construction is published by Mr. William Booth Scott, M. Inst. C. E., in his handbook on "Cleansing Streets and Ways." in the Internationol Health Exhibition Series. The author writes:—"London street mud is a noxious and destructive compound, injurious to clothing, to carriages, and to harness. It has been stated by Mr. H. Graves, the eminent print publisher, that he can clean an engraving from oil, or from ink, or from ordinary dirt, but not from London street mud." Mud is chiefly the working upwards of the substratum through a defective foundation or pavement, though other ingredients are present, such as stone, horse-droppings, shoe iron, and shoe-leather. From an analysis made of the mud collected from the stone-paved streets of the City of London, and dried to a temperature of over 266°, it appears that the maximum organic matter in dry weather is 58.2 per cent., and the mineral 41.8; the minimum organic in wet weather is 20.5, and the mineral 79.5. The higher proportion of mineral matter in wet weather shows that the abrasion of stone and iron is then greatest. Dr. Letheby estimated the average proportion of stone, iron and manure as under:

Abraded stone	30 per cent.
" iron	13 " "
Horsedung	57 " "
	100

The mud was so finely comminuted that floated away in a stream of water. Wood pavements are found to yield the larger proportion of organic matter. The detritus of macadamized roads is largely composed of the abraded material of the roadway, Herr Bokeberg, Hanover, made careful experiments to find the proportion of vacuity to solid material, and ascertained that in a loosely heaped cubic yard of broken stones the void space amounted to one half of the volume. With stones that had become rounded at the edges and corners, the vacuities were reduced to 37 per cent. of the gross bulk, or to 10 cubic feet. A cubic yard of broken stone metalling (of 2 inches to 2½ inch cube), when screened and beaten down in layers 6 inches thick, contains, it is said, 11 cubic feet of vacuities. These results show the reduction of interspaces by compression. It is stated by the author "In by far the greatest proportion of the detritus of macadamised roads, consisting of the worn material of the road, the important principal was early revealed by experience that the oftener the streets are cleansed the less is the mud which is created and removed, whilst the attendant expenses are by no means increased, and the roads are kept in a better state of preservation." The loose particles remaining on the surface act as a grinding powder under the wheels, adding to the detritus, which after rain becomes mud, and operates as a sponge in retaining moisture on the surface. Experience has proved the advantage of sweeping machines in reducing the quantity of mud, and the statistics from Manchester and Birmingham have established the fact that with the proper use of water and sweeping a saving of fully one-third of the material required for the repair of roads is effected. The comparative values of manurial element of refuse from streets of stone pavement, wood and macadam are given by Dr. Letheby as follows:—For stone paxement 22.8 per cent. of the mud collected is the proportion of the manurial element; for wood pavement the dried mud contained 60 per cent of organic matter; for macadam an average of 4 per cent. of the whole quantity of mud collected is estimated as the quantity of organic matter.

The N. Y. Public Works Department.

Commissioner Squire, of the Department of Public Works, July 14th, sent to Mayor Grace his report for the first quarter of the present year. The report shows that $882,099.39 was expended and that the receipts were $603,506.27 from Croton water rents, and $53,783.79 from other sources. Sixteen contracts, at an estimated cost of $91,850.60 were entered into for sewers, pavements, water pipes, and miscellaneous purposes, and 22 contracts, at a cost of $217,405.85, for pavements, sewers, grading, etc., were completed.

In reference to the water supply the Commissioner says: "The rainfall in the Croton watershed for the three months was 5.72 inches, which is less than for the same period during the past 18 years. On June 12th, the natural flow of the Croton River ceased to be sufficient to supply the aqueduct to its full capacity, and it became necessary to draw upon the stored waters in the reservoirs and lakes to supply the deficiency. In the short period from that date to the close of the quarter 1,320,000,000 gallons were drawn. In extending the distribution of water into new streets and avenues 21,811 lineal feet of pipes were laid, and 550 additional water meters were placed, making a total of 12,075 water meters in use on June 30th."

The report says that 38,500 square yards of pavement have been repaired by day's work

and 2,073 square yards relaid by contract. New pavements, to be paid for by assessment, were laid on nine streets in the upper part of the city, covering an area of 19,400 square yards. During the quarter four miles of gas and steam pipes and nine miles of underground telegraph and telephone wires were laid. The present extent of the sewerage system on Manhattan Island is given as 409 miles, with 5,119 receiving basins. During the quarter 6,079 lineal feet of new sewers were built, and 5 lineal feet of culverts. The Commissioner alludes to the consolidation of the gas companies as having prevented competition for lighting the city; yet he says the prices for the year beginning May 1st, are the same as for the preceding year. On June 30th, there were in use in the city 22,962 gas lamps, 703 electric lights, and 50 naptha lamps. Since the 11 free baths were opened they have been patronized by 274,778 males and 98,404 females. There were 1,226 complaints received of obstructions on streets, and 3,049 permits were issued for placing building material on the streets.

CORRESPONDENCE.

The Metric System Rebuked.

HADES, July 21st, 1885.

EDITOR ENGINEERING NEWS:—Owing to my considerable distance from New York the NEWS is late in reaching me, and this accounts for the fact that I have just had the pleasure of reading Mr. North's admirable rebuke to the zealots of the metric system. I trust, however, that it is not yet too late to express the gratification his letter gives me in the assurance that the good old conservative race has not yet become extinct, and that there are yet those who will lift up their voice in defence of the grand principle that what was good enough for our grandfathers is good enough for us and *ought to be* good enough for our grandchildren.

On earth it was my greatest pride, and here it is one of the greatest of my few pleasures, that in my time I took the same ground. When it was proposed to depart from the time-honored currency of pounds, shillings and pence, and to substitute the absurd and abominable dollar and cent with which the country has ever since been handicapped, I was one of the foremost in opposing such nonsense, but the crack-brained young fellows of the day would hear no reason, and they were in the majority, and now what have you got for their pains? And what was the still greater enormity which these supposed servants of the people perpetrated upon those of their own generation? Instead of being told that a coat was to cost him £3, 1s. 7d., which would have conveyed some idea of the amount involved, we were told that the price was $15, that is fifteen times some undetermined and undeterminable thing, and anyone who wished to derive any intelligent idea from such an answer was obliged, as Mr. North is now, to sit down with pencil and paper and go through an arithmetrical calculation. And these men, who fostered this monstrosity upon the country were supposed to be paid, as are those now in charge of the forestry report, to serve the people, instead of which they, again like these modern disturbers, saddled upon them and their unfortunate descendants this intolerable burden.

Those of us who saw the folly of the proposed innovation protested (as is done now by the patriotic opponents of this metric craze) that the decimal system was quite imperfect and faulty and that before plunging the country into such a sea of inconvenience it would be better to wait until some more rational system, such as that with 16 as a basis, should be substituted for the irrational 10. But youth and folly carried the day, and the consequence is that the country has ever since been groaning under the misery of an absurd and inconvenient system of currency.

And yet, Mr. Editor, there are those among the apostles of this new metric gospel who will stand up and say that the advantages of the substitution of their hobby, in the way of facility of calculation and what not, would vastly more counterbalance the inconvenience of making the change. I need hardly say that we heard such silly arguments in my day.

Thus history repeats itself, but I trust the respectable people who love the good old ways will continue to be outspoken in condemnation of these mad-cap schemes, and thus save my old country from this new curse, which can hardly be less disastrous in its effects than the change from pounds, shillings and pence to dollars and cents.

STATU QUO.

[We publish the above communication not for the light it throws on a much disputed question but rather for the novel manner in which it tells a story often told before. We hold neutral ground in this "battle of the measures," as we believe the unit of the future, perfect measure is yet to be discovered; hence our columns are open to the advocates of the *metre* or the "English circle."—ED. ENG. NEWS.

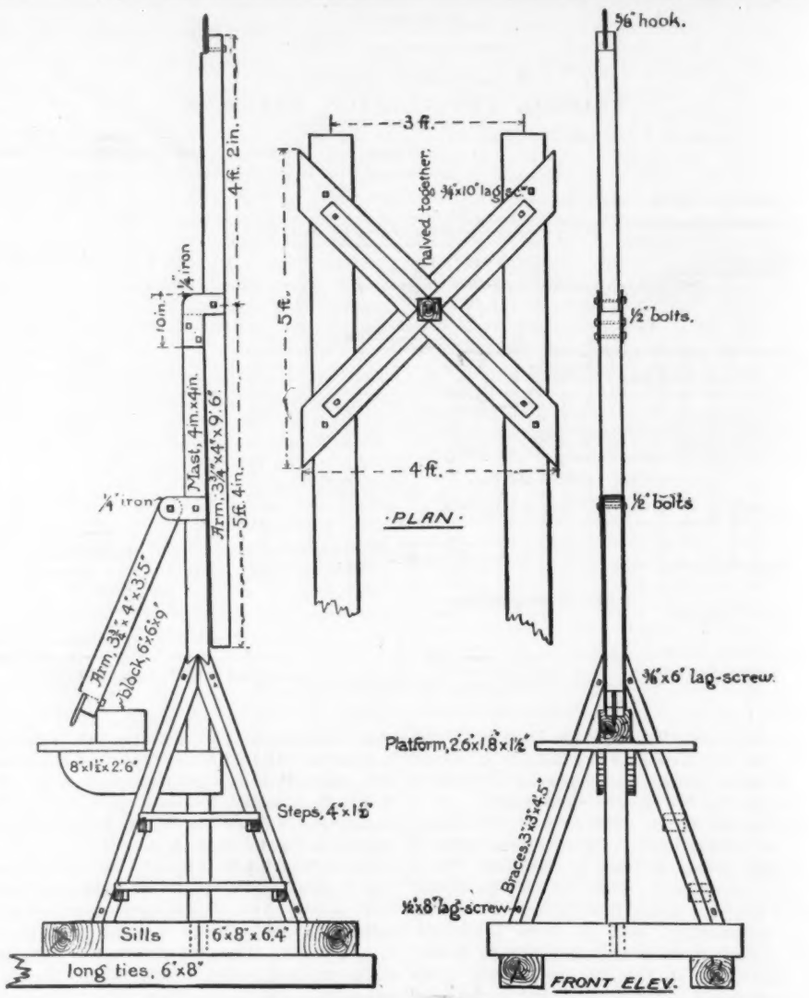

FIG. 109.—MAIL CRANE.

The Irish Ship Canal.

The failure of the Channel Tunnel scheme has not daunted Sir E. W. Watkin, for he has come forward with another for the construction of a ship canal from the east to the west coast of Ireland. There must be less objection to his new scheme. At one time it was considered a wise policy to ignore the physical advantages of Ireland. Lord Sheffield opposed the repeal of the Navigation Laws on the ground that England had been handicapped by nature in the competition with Ireland for trade. "Ireland's object," said his lordship, "is to become the mart of Europe for the trade of America for which she is so well suited by her western situation, immediately open to the ocean, and accessible almost with every wind, her vessels often crossing the Atlantic in a shorter time than the shipping of London require to clear the Channel." A wiser spirit now prevails, and in the endeavour to maintain British trade it would be absurd to think of Ireland as a rival. Sir E. W. Watkin proposes to construct a ship canal in the first place from Dublin to Athlone, which is the centre of the island, and where the Shannon could be utilized. There is a line of canal in the same direction which was once used for passenger and goods traffic, and is still used for the latter. Its existence is evidence of the feasibility of the new scheme. Afterwards the second portion of the canal, between Athlone and Galway, would be made. Sir E. W. Watkin's idea is "that the canal should not merely be a navigable watercourse for the largest ships, but also practically a long dock from one end to the other, upon the margin of which various trades might be carried on." The Manchester canal is to have a corresponding purpose, and if the two works are carried out a transference of trade centres to their banks is inevitable, and consequently there must be new buildings to an almost unlimited extent.—*Architect*.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 60*).

Of mail cranes there are more varieties than there are roads, but the one shown in Fig. 109 has substantial claims for efficiency, durability and simplicity of construction. At the side there are steps to permit one to mount to attach the mail pouch to the arms. The braces are secured at top and bottom by lag screws, while the mast at the bottom is framed down to 3 in. by 3 in. and let into the sills, and these latter are held to the ties by lag screws. The length of the mast depends on arrangement of mail car, while the distance it is from the rail varies according to length of arms and width of car—thataverage width of car and length of arms as shown this distance would be about 7 feet.

The great point in favor of design of Fig. 109 is that it rests on two long ties and thus becomes really part of the track instead of independent of it, as is usually the case. Thus when the track heaves in winter, the mail crane goes with it, and trackmen in performing regular repairs can not throw it ou-of adjustment. To set a crane, a right angled gauge should be used, one arm of which sets down over the rails and the top end of the upt right part is so adjusted as just to touch the end of the upper crane arm when revolved into position.

The buildings which specially belong to the

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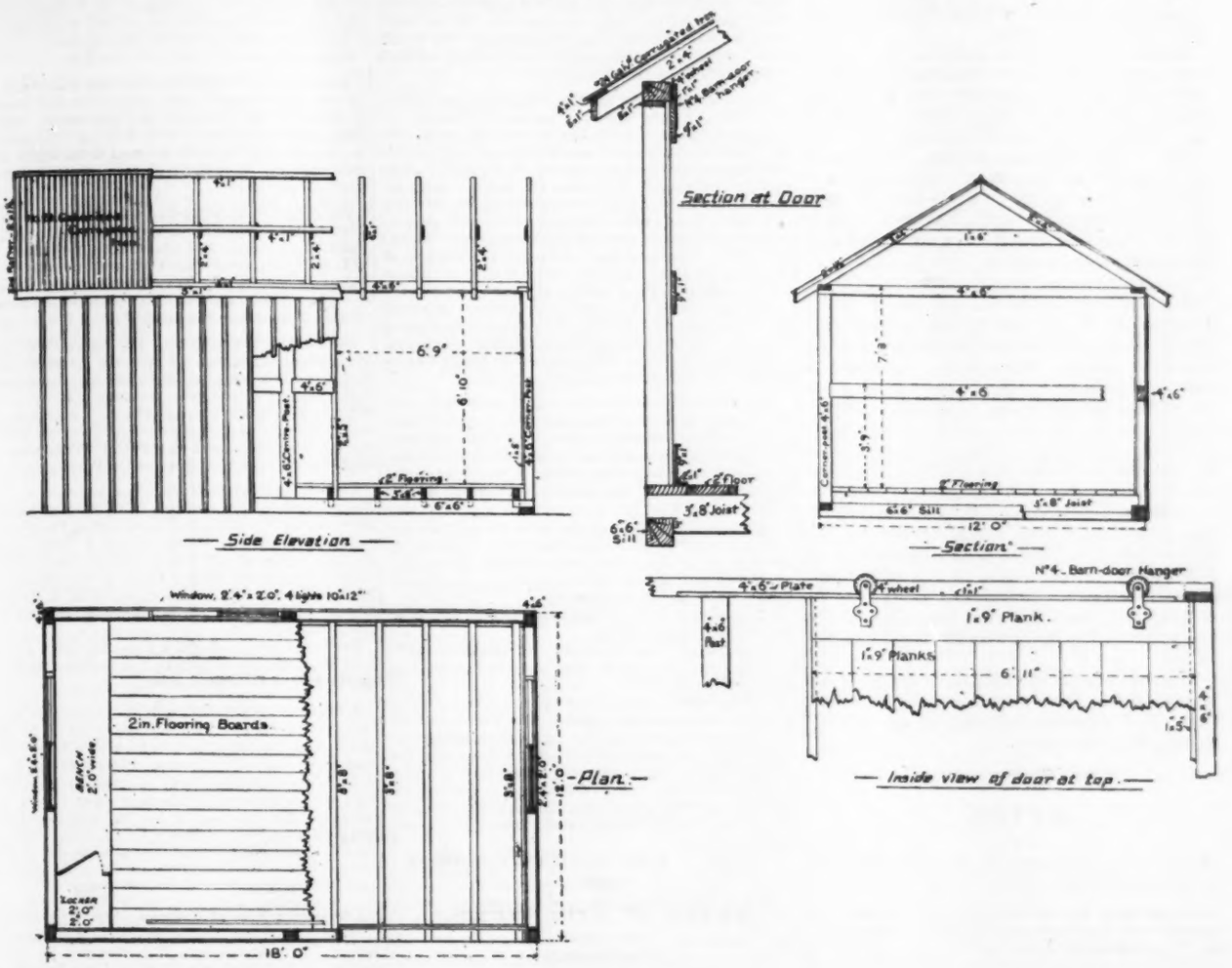
FIG. 111.—TOOL HOUSE.—(See Track, Page 76.)



Track Department are usually three: Tool or section houses, flagman's cabin, and dwelling "shanties." Of the first the requirements are that it will be large enough to hold the handcar, the tools and supplies, and leave sufficient room for the men to move about. It is best to have the house stand parallel with the track to permit the door to slide; and also to give easier entrance when car is run in. The door should slide and not open on hinges. Full details with dimensions are shown on the plan of a conveniently arranged houses Fig. 111. It is preferable to have the house set next to a side track rather than the main track, so that the men can take their car in and out without interfering with trains. The house should be set back far enough from the track to permit the handcar to stand between the house and rail without danger of being struck by passing trains. The arrangement shown in Fig. 112 is a sort of turntable which trackmen generally make themselves, as an easy method of transferring them to and from the rails. The frame is portable and is set down on the block (into which the pivot pin passes) the the car is then run up on it, when it can be easily revolved. This saves time, but more especially the car, for which nothing is more injurious than the severe handling it gets when it is lifted (?) on or off the rails.

(TO BE CONTINUED.)

Canadian Public Works.

Among the supplementary estimates of the Canadian Parliament, for which an additional vote of $2,000,000 is required, are the following:

RAILWAYS AND CANALS CHARGEABLE TO INCOME.

Surveys of Cape Breton and other railways, $12,000; Cornwall canal, construction of a drain between the town and the canal, $20,000; Welland, canal land and damages, Grand river, $16,000; towards filling a pond near St. Catharine, $500; Grenville canal, to pay Mr. J. Simard for services, $75; Rideau canal, to pay land damages in the township of Pittsburg, $550; miscellaneous repairs to road dyke along Lake St. Francis, $4,000.

HARBORS AND RIVERS.

Nova Scotia—$12,550. Prince Edward Island, $13,650. New Brunswick—$4,000. Quebec—Marsh and Ditchfield, Lake Megantic, piers, $750; Matane, completion of breakwater east of river, $1,500; St. Michel, repairs to pier, $1,000; River du Lièvre, improvement to channel, $10,000; Baraches de Malbaie and mouth of Newport river, $1,000; St. Francois, Island of Orleans, $1,500; River Yamaska, $10,500; St. Anne de Sorel, ice pier, $1,000; River St. Anne de Beaupré $2,000; Gatmeau Point, protection pier, $4,000. Ontario—Chantry Island, protection of island and lighthouse, $5,000; Lion's Head breakwater, $2,500; Midland harbor, revote, $10,000; Little Nation river, removal of obstructions, revote of $2,000; lapsed $3,000; River Ottowa, improvement of channel, upper to lower narrows, above Pembroke, $2,000; Little Bear creek, $2,250; Toronto harbor, $30,000. Manitoba—Red river, mouth of river, $5,000. North-West Territories—North Saskatchewan river, $10,000. British Columbia—Victoria harbor, removal of dredger rock, $7,500; Nicomickel river, removal of snags, $1,000.

SLIDES AND BOOMS.

River Coulonge slide, revote, $11,000; Carillon slide and booms, river Ottawa, $5,000.

ROADS AND BRIDGES.

Aid towards construction of a bridge across the Elbow river, near Calgary, $1,000; aid to the municipality of New Edinburgh toward the erection of an iron bridge across the east channel of the Rideau river, at the highway leading to Rideau hall, $3,000; bridge at Des Joachims Rapids river, additional amount required $1,500; Suspension bridge and approaches, Ottawa, $1,600; Portage du Fort bridge, $5,000; aid to the municipalities of Calumet and Bryson, towards the construction of a high level suspension bridge over the Calumet channel river, Ottawa, provided the municipalities contribute $8,000, the Quebec Government having granted $4,000.

NOTE.—Fig. 112 is unavoidably crowded out, we will give it in next issue.—ED. ENG. NEWS.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.; M. INST. C. E.

(CONTINUED FROM PAGE 46)

DCCLXVI.—SALIDA, COLO.

Salida, Chaffe Co., Colorado, in lat. 39° N., long, 107° W, is in a valley 10 miles long and from one to five miles in width on the Arkansas River. The site of the town is level and is surrounded by high mountains. It is 8,000 feet above the sea.

The town was settled in 1880, and incorporated in the same year.

Water-works were built in 1882 by the city after plans of Russel & Alexander, and under the direction of J. E. Ford, taking the supply from the South Arkansas River, a small stream running along the foot of a mountain range. A dam 100 feet long, constructed of stone and brush, forms an impounding reservoir, from which the water is conducted in a

wooden flume 65 feet to a wooden tank 20 feet long, 10 feet wide and 8 feet deep, holding 12,000 gallons, and being 2 miles distant from and 230 feet above the town.

Distribution is by 3 miles of lap-welded wrought-iron pipe with converse lock joints, of 8 to 2½ inches in diameter, with 11 fire hydrants and 40 taps. There are no meters in use. Service pipes are of wrought-iron.

The works have cost $20,000. The bonded debt is $31,000 at 8 per cent. The receipts to date have been $5,500. The yearly expenses of maintenance are $1,000, and the receipts $2,000. The population is 2,500. Daniel A. Cramer is Superintendent.

DCCLXVII.—SAN LUIS OBISPO, CAL.

San Luis Obispo, California, in lat. 35° 20' N., long 120° 45' W., the county seat of San Luis Obispo Co., is in a mountainous and heavily timbered region. Water-works were built in 1874 by a private company, the supply being taken from surface water. The waters of San Luis Creek are impounded in a reservoir having a storage capacity of 20,000,000 gallons, and are thence conducted to a distributing reservoir constructed in earth excavation and embankment, holding 2,000,000 gallons and being two miles distant from and 150 feet above the highest portion of the city. Distribution is by 9 miles of cast-iron pipe of 7 to 2 inch diameter, with 22 fire-hydrants and 250 taps. No meters are in use. The city does not pay for fire service. The daily consumption is 250,000 gallons.

The works have cost $75,000. There is no bonded debt. The population in 1880 was 2,243. J. P. Andrews is President, and F. W. Eagan, Superintendent.

WATER.

A SCHEME is on foot to supply Brunswick, Ga., with gas and water-works.

SMYRNA, DEL., has voted by 1087 to 449 in favor of water-works. The Commissioners are now fairly engaged on preliminary measures.

PIPE laying (13 miles) at Fondry du Lac, for the new water-works commenced on the 21st. There are to be 140 hydrants. The Holly Mfg. Co. have the entire contract, and in payment are to receive an annual rental of $9,000 for 30 years.

THE tube manufacturers of the United States met at Pittsburg, Pa., on the 22d inst., for the purpose of forming an organization to maintain prices. The matter was considered at length, but nothing definite was done. It is stated that every tube-works in the country was represented.

THE contract for the engine of the Montreal Water-Works has been awarded to Mr. H. R. Worthington. The total cost will be $51,150, the same to include the foundation for the engine, the contract to be completed by the first of December.

DAVIS'S POND, covering an area of about forty acres, has been purchased by the New Rochelle, N. Y., Water Company. The work of cleaning out the pond and laying the pipes to the village, a distance of three miles, will be begun about August 15th., under the direction of Mr. J. J. R. Croes.

THE people of Holland will soon be defended from invasion by a water line from five to ten miles wide and some sixty miles long, directly barring the advance of an invader coming from the East. Above the surface of this inundation nothing will be visible but a few narrow roads raised on embankments, enfiladed by fortifications bristling with cannon. The water, for the most part, will be only a few inches deep, so that it will not be navigable by hostile gun vessels or flotillas while deep trenches cut in the ground below will frustrate any attempt to wade through the inundation.

A PATENT for an Improved Surface Condensor has been lately taken out by Mr. Fredk. M. Wheeler, of the Knowles Steam Pump Works. The design of this Condensor does away with all forms of ferrules and packing for the tube heads, and yet allows the tubes to expand and contract freely. The circulation of the condensing water is very active, making the cooling surface more efficient than in the usual form of Surface Condensers. The tubes are straight and can be taken out, cleaned, and replaced by unskilled labor. The Wheeler Surface Condenser will be introduced by the Lighthall Manufacturing Company of 97 Liberty street New York.

A NEW system of water supply at Fortress Monroe Va., is now nearly completed, and will furnish an ample supply for domestic, sanitary, and fire purposes. Wells have been sunk about a mile west and the water is raised to a tank placed on the ramparts. Up to this time the garrison has depended upon cisterns for their supply, which are not always reliable.

AT a meeting of the Croton Aqueduct Commission, July 15th, the Chief engineer presented a request for the appointment of seven Inspectors from among the approved applicants, and recommending certain persons for the position; whereupon, on motion of Commissioner Baldwin, the following persons were appointed Inspectors, with compensation at the rate heretofore fixed by the Commissioners, said compensation to commence when they are assigned to duty by the Chief Engineer, viz.: John Kelly, Thomas J. Keogh, John S. Stevenson, George B. Francis, James Lyons, Edward O'Shea, and Patrick Daly.

The Chief Engineer in accordance with the request of the Commissioners, of May 20, presented a draft of rules for the government of the Engineer Corps and care of the property of the Commission; which was referred to the Committee on Construction.

THE Board of Public Works and Affairs of Nashville Tenn., have a large surplus over the cost of already contracted improvements in their city water supply, it has, therefore, presented to the City Council a recommendation for the construction of a double pump house instead of the one heretofore proposed for the following reasons:

1. Prudence in the management of the engines and pumps, as well as the increasing demand for water, will in the near future require another set of pumps.
2. If two wells are needed, it is cheaper to build a double well than two single ones.
3. The money to make the improvement has been raised and is now on hand.
4. Owing to the scarcity of work, the strong probability is that the work can be done cheaper now than at any time hereafter.

They therefore submit to you this new plan, on which bids have been received, together with new estimates, accompanied by our ordinance appropriating the additional $28,375, to enable the Board to carry out the change proposed. It is distinctly understood, however in the minds of the Board, that this is not in reality an additional appropriation to the general sum heretofore appropriated for the general work. Respectfully submitted,

BOARD OF PUB. W'KS AND AFFAIRS.

NEWS OF THE WEEK.

Contracting.

A Monster Hotel, with steam tramway connection is projected by capitalists who propose to bring Long Island beach, Ga. to the front as a summer resort.

Cleveland Ohio Contract.—City Engineer Force advertises for bids for street grading and paving, to be sent in before August 12th. The Water-works Superintendent will receive proposals up to August 6th for iron fencing, and light iron bridges.

A Big Car Contract.—ST. CHARLES, MO., July 22.—The St. Charles Car Manufacturing Company has contracted to build 300 coal cars for the Kansas City, Clinton and Springfield Railroad, to be delivered within the next sixty days.

Gibb's Cement.—The contract for Portland Cement required at Fort Adams, Newport Harbor, R. I., was recently awarded for Gibb's English Portland Cement. This is the same cement used, to the extent of 10,000 tons, in the New Haven Breakwater, England, described in the last issue of ENGINEERING NEWS.

Bids for Repaving Fifth Avenue.—When Mayor Grace, Controller Loew, and Commissioner of Public Works Squire met yesterday to consider the proposals for the repavement of Fifth Avenue, they found on their desks the following tabulated statement of each contractors bill:

	Lowest.	*Highest.*
L. W. Johnston, four bids	$274,240	$371,277
M. Baird, four bids	318,004	429,339
Abram Dowdney, two bids	456,000	461,638
J. Cranford and David Valentine, four bids	460,330	563,180
Robert McCafferty, two bids	569,178	614,337
Charles Guidet, two bids	585,288	676,068
William H. Harrison, one bid		757,330

Corporation Counsel Lacombe advised that the commission could not award the contract, as the lowest bidder, Mr. Johnston, and two other bidders had not complied with the rules governing the bids. One of the rules specified that a plan of the proposed pavement should accompany each proposal. Mayor Grace thought the contract should be awarded to Mr. Johnston, who, he said, was able to do the work well. Commissioner Squire, however, held that Mr. Johnston's bid was too low for good work, and said that the city would be put to great trouble in seeing that he did not evade the terms of the contract.

All the bids were then rejected, and new ones will be advertised for.—N. Y. *Times.*

Dock Contract.—Proposals for labor and materials for a building to be erected on Pier A North River will be received by the Department of Docks, 117 and 119 Duane st., until Tuesday, Aug. 11, 1885, at 12 o'clock M.

For full information see the City Record.

Copies for sale at Room No. 2, City Hall.

Assignment of a Contractor.—SAN FRANCISCO, July 28.—The announcement was made yesterday that John A. Benson, a civil engineer and contractor, made an assignment on Saturday to W. S. Wood. His liabilities are $450,000, and his assets are said to be equal to his indebtedness. It consists of real estate in different parts of California.

The New Jersey State Capitol.—TRENTON, July 28.—The Capitol Rebuilding Commission met to-day and had a long session. Six plans were presented. That of L. H. Broome, of Jersey City, received the prize of $200 and was accepted. The dimensions of the building are 60 by 166 feet, or 60 feet longer than the old building. Work will begin sometime this year.

Contract for Curbstones.—The contract for furnishing six-inch curbstones for Hanover, German, Charles and Franklin streets, Baltimore which are to be repaved with Belgian blocks, was awarded July 20, to the Woodstock Granite Company at 64 cents per linear foot, and $1.33 per foot for circular curbs. There were no bids for gutter stones, and the City Commissioner was authorized to purchase them on the best terms.

Granite and Brick Work.—The following is a synopsis of bids for granite and brick work of basement and area walls of the court house, etc., at Pittsburg, Pa.

Adams & Snyder, $13,588; Booth & Flynn, $38,298; Booth & Flynn $39,290; David Tillson, $39,500; Huckestein & Co., $41,000; Martin Joyce & Co., $41,423; M. L. Malone, $41,500; M. L. Malone, $42,543 W. F. Patterson, $43,000; F. Gwinner, $43,499; Bodwell, Granite Company, $44,400.

The bid of Messrs. Booth & Flynn has been accepted they being the lowest bidders complying with the requirements of the specification.

A Big Coal Contract.—Forty thousand tons of Alabama splint coal has just been contracted for by the M. and O. R. R. for use on their engines and in their shops during the next twelve months. Last year the M. and O. R. R. used only about half of quantity of Alabama coal, and that was of Corona and other varieties; the balance of the coal used by the road came from Illinois and Kentucky, but after careful and exhaustive tests they have now settled upon the splint as the best and cheapest coal for their purpose it seems, and have given their large contract to one company.

A Pleasure Pier at Chicago.—The Brighton Pier Company, of Chicago, proposes to build a pier into the lake at Thirty-first-street. The Pier will be of iron, similar in construction to that at Long Branch, and devoted to a similar purpose. The length will be from 500 to 600 feet and the width 64 feet. The pier will be reached by a viaduct crossing the railroad tracks at the foot of Thirty-first street. There will be a pavilion, band stand, refreshment pagoda, and possibly bathing and boating houses. The Long Branch pier cost $125,000, and it is expected that the Chicago pier will cost from $25,000 to $50,000 more.

Street Grading and Prices at Lancaster.—Grading Laurel street, between High and Buttonwood; Hugh Keogh, 17 cents per cubic yard for 750 feet; 1½ per cent. cubic yard additional for every 100 feet hauling distance, G. Suter & Bro, 18 cents per yard and rock 50 cents cubic yard. John Kendig, earth 14¾ cents per yard and 35 cents per yard for rock. Frank Hinder, earth 18 cents, rock 50 cents per yard. H. Shaub, earth 16 cents per yard, 50 for rock, John W. Musser, 13¾ cents earth per yard and 45 cents rock per perch. Samuel Resh, 14 cents earth, rock 40 cents. Jacob Benner, 16½ cents earth, rock 25 cents per yard, Davis Kitch, 14 cents earth, rock 50 cents per yard. And. Gable 19½ cents earth, rock 25 cents per yard. John Gill, 13½ cents per yard. Geo. Kolb & Son, 15 cents per cubic yard and rock 50 cents per perch. The contrac was given to John Gill at 13¾ cents per yard for stone for macadamizing.

Delaware River.—Abstract of proposals received and opened July 23, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers, U. S. A.:

For Constructing a Dike between Hog and Maiden Islands:

Frank Pidgeon, New York	$90,590
Herron & O'Rourke, Bordentown, N. J.	79,977.50
American Dredging Co., Philadelphia	55,565.
J. P. Eyre & Co., Philadelphia (Informal)	53,170.
John Satterlee, Englewood, N. J.	49,800.
Samuel R. Cumming, New York	45,250.
John A. Bonker, New York	44,835.
Neveling & Co., Philadelphia	43,390.
John F. Dawson, New York	42,212.50
Elijah D. Register, Lewes, Del.	34,300.

For Constructing a Dike Between Fisher's Points and Petty's Island;

Frank Pidgeon, New York	$81,464.
Herron & O'Rourke, Bordentown, N. J.	73,915.
American Dredging Co., Philadelphia	52,264
J. P. Eyre & Co., Philadelphia	48,598
John Saterlee, Englewood, N. J.	48,300
Samuel R. Cumming, New York	42,256
John A. Bonker,	41,404
Neveling & Co., Philadelphia (Informal)	40,960
John F. Dawson, New York	40,595

Railroads, Bridges and Canals.

Anniston & Atlantic R. R.—The directors of this narrow-gauge road have decided to build it to Montgomery (Ala). The route will probably be by way of Rochford.

R. R. Grading.—Larson & Co., representing D. C. Shephard & Co., of St. Paul, who have received the contract for building the Dubuque and Northwestern Railroad from Dubuque to Durango, have commenced grading at Dubuque, Ia.

Missouri Pacific Extension.—The management of the Missouri Pacific railroad have ordered the immediate construction of a southern connection on their main line at San Antonio, Tex., with the San Antonio & Arkansas Pass R. R.

Mexican Finances.—It is an open secret that the Mexican Cabinet is daily discussing means and methods looking toward a partial resumption of the payment of railroad subsidies, and it is only a question of ability to resume that stands in the way.

Chicago, Wisconsin & Northern R. R.—A meeting of the local representatives of the Chicago, Wisconsin & Northern railroad was held at Waukesha, Wis., July 21st., and it was decided to commence work upon the road surveyed immediately. It is thought the road will be completed as far as Waupun before snow flies.

Building a Branch.—Work on the Rock Island branch was commenced at St. Joseph, Mo., July 21st., by a large force of men and teams. In Daviess County, forming the other end of the road, work is also in progress. A thousand men will be put on in a short time. The grading must be completed by the 1st of November and the track down by the 1st of January.

The Burlington & Missouri has recently let the contract for the construction of a line extending from Holdrege, on the cut-off branch, to Elwood, a distance of nearly forty miles. This company has determined to extend this line still further in the same direction this season, and the contract for about thirty miles more will be let at an early date.

Kingwood R. R.—Morgantown and Kingwood, W. Va., have now a fine prospect for a connecting railroad in the near future. Contracts for building and equipping "the Kingwood Railway Company's narrow gauge railroad," from Kingwood to Tunnelton, have been signed, and under them the road is to be ready for operation by January 1st, 1886.

The "Williams" R. R.—New Hampton (Ia.) special to the *Chicago Tribune* says: The grading of the "Williams" Railroad is progressing as rapidly as it is possible with a force of about seventy-five teams. Mr. Williams says that seventy miles north from Independence, on the Illinois Central, will be finished this fall, and conveys the idea that he is confident of success.

Canadian Pacific.—General Superintendent Egan, of the Canadian Pacific, is quoted by the Winnepeg *Free Press* as saying that the road's southwestern branch will be at once extended from Manitou some seventy miles, to the vicinity of Oak Lake. Profiles of the works are now being made, and so soon as completed contracts will be let.

The Jetties.—Major Heuer, of the Corps of Engineers, has submitted his report of the progress of work on the improvement of the South Pass of the Mississippi River for the past fiscal year to Gen. Newton, Chief of Engineers. He says: "One of the interesting facts connected with the improvement is that the full depths and widths of channels required by law have been maintained throughout the year by Mr. Eads, and that no dredging of any kind has been required on any of this work since February, 1883. No work has been done in the pass or at the head of the passes during the year. The inner east jetty has been extended 605 feet. * * * Considering the channel in the pass, jetties, and just beyond the jetties during the year as a whole, it is in better conditions now than it was at the end of the previous year."

A New Connecting Line.—Articles of association of the Hudson River and Boston Railway Company have been filed at the Capitol. The company is to continue for 100 years. The route to be constructed is as follows: Commencing at a junction with the tracks of the Poughkeepsie, Hartford and Boston Railroad at Ancram Station, Columbia County, thence running northeasterly through the towns of Ancram, Copake and Hillsdale, in said county, crossing the New York and Harlem Railroad north of the Copake Iron Works, and thence to the westerly line of the State of Massachusetts. The length of the road is to be 14 miles. The amount of capital stock is fixed at $1,500,000, consisting of 15,000 shares of $100 each. The thirteen directors are P. P. Dickinson, J. C. Stanton, William H. Kirby, C. C. Dickinson, H. J. Davison, James W. Coffin, all of New York City; George P. Pelton, J. A. Perkins, John I. Platt, Edmund Storm, Poughkeepsie; William A. Miles, Copake; Charles O. Colton, Brooklyn, and H. F. Keith, Great Barrington, Mass.—*Albany Express.*

Part of a Road Sold.—LITCHFIELD, ILL., July 25th.—The road-bed, rails, ties, and right of way of the Chicago, Springfield and St. Louis Railroad in North and South Litchfield Townships was sold today to satisfy a chattel mortgage in favor of John J. McLean and H. H. Beach. It was bought in by the mortgages for the amount of their claim and costs. The purchasers are prominently identified with a company lately formed to complete the road from Springfield to this city.

St. Louis Cable R. R.—The first shipment of 396 feet of tubing for the cable line reached St. Louis July 23rd. Each section of the conduit is 18 feet long, exclusive of the rails, and weighs 2,000 pounds, they will be laid in 6 or 9 inches of concrete. Fruin, Bambrick & Co., have the contract for excavation and concrete, and commenced work, July 27th. It is expected the road will be completed some time in October.

Arizona Central R. R.—G. F. Hamilton, President of the Arizona Construction Company, and C. M. Wilson, President of the Prescott & Arizona Central Railroad, are in Washington and have filed an application for right of way for the road with the Secretary of the Interior. Messrs. Hamilton and Wilson are residents of St. Paul, and are said, represent a syndicate of Minnesota capitalists.

New R. R. Projects.—A good many new railroad enterprises are being reported. Among others are a 280-mile road projected in Arkansas, a 100 mile road in Tennessee, a new road from Minneapolis to Chicago, a road from Amsterdam, N. Y., to Saratoga, a 114-mile road from Indianapolis to Vincennes, Ind., by C. P. Huntingdon; a long line from Sioux City to Des Moines, a road from Bristol, Tenn., into Virginia, besides several smaller roads.

New Waterloo Route.—The mileage of the several roads making up the new Waterloo route of the Minnesota & Northwestern R. R. from St. Paul to Chicago, 482 miles, as is shown by the following table:

	Miles.
Minnesota & Northwestern to Mona	110
Illinois Central to Forreston	254
Chicago & Iowa to Aurora	80
Burlington & Quincy to Chicago	38
Total	482

R. R. Depots.—At a meeting of the St. Paul, Minn. Union Depot directors, July 21st., the president was instructed to have plans prepared and bids asked for the construction of a shed to cover the depot tracks. The plans have been prepared, and within the next few days will be submitted to the chief engineer of the several roads. They provide for a shed 500 feet long, 170 feet wide and 50 feet high. It will cover all the tracks and will extend from the depot buildings to the other side of Broadway. It is expected that work on the shed will be commenced by Sep. 1st, and be completed before winter sets in.

Duluth & Winnipeg.—Oliver W. Barnes of New York city, one of the capitalists who is reported to be interested in the purchase of the Duluth & Winnipeg branches and road beds, has sent here J. Opperman, the civil engineer of Buffalo, N. Y., and formerly of the engineering corps of the Lehigh Valley road, with instructions to personally go over the line of the proposed road and examine its location, report on the value of the work already done on line and what changes should be made, etc. Mr. Opperman with two woodsmen started to his work July 25. He will be two months in making the examination.

Sale of a Bridge.—LEAVENWORTH, KAS., July 21st.—The west half of the Missouri River railroad bridge at this place was bought in to-day because of nonpayment of taxes by John Hannon, of this city, for $15.000. The bridge cost $1,000,000, and the west half was assessed at $100,000. The company refused to pay the taxes because the bridge was assessed as real estate instead of as personal property as the law requires. In six months the west half of the bridge will be deeded to the holder of the tax certificate unless the taxes are paid to the holder of the certificate. There is much dissatisfaction with the manner of assessing property in Kansas. Assessors are appointed for townships, and are changed every year instead of being chosen for a term of years, as was formerly the case.

N. Y. & Ridgefield R. R.—At a public meeting held at Danbury, Conn., by the directors of the New York and Ridgefield Railroad and others interested in its completion, the officers of the company stated that the object of the meeting was to ascertain whether the people living along the line of the road were ready to put their shoulders to the wheel to secure the completion of the road upon the conditions which the Board of Directors were prepared to offer. The company had expended about $250,000 and is free from debt. It would require about $350,000 more to complete the road to Wierbridge, near Danbury, where it would connect with the New England Railroad, and to furnish the necessary rolling stock. The directors only ask that the people interested in the matter subscribed for the necessary amount of stock, payment for which will not be demanded until the road shall be completed and the rolling stock in successful operation for a period of thirty days, such completion to be accomplished on or before January, 1, 1886.

It is believed that the necessary amount will soon be subscribed.

Railway Mortality Statistics.—The board of railroad commissioners of the State of New York reports that for the year 1884, 488,028,200 passengers were transported by the various kinds of railways. Of this number the horse roads carried, 319,642,780; steam surface roads carried, 72,125,842; elevated roads carried, 97,259,578.

The largest number carried by any one road is the Manhattan Railway Company (elevated,) 96,702,620; of which three were killed, or one in every 32,234,206; wounded eleven, or one in every 8,791,147.

Ever since the New York elevated railroads have been in operation, but one passenger was killed while being transported, and he through his own fault, in refusing to heed the advice of a guard not to sit on a car railing.

The street horse roads killed 16, or 1 in every 19,977,674; wounded 122, or 1 in every 2,620,023. Steam surface reads killed 22, or 1 in every 3,278,447; wounded 176, or 1 in every 409,805. New York city horse roads carried 184,504,998; killed 10, or 1 in every 18,450,499; wounded 55, or 1 in every 3,354,636. New York Central Railroad carried 11,057,939; killed 4, or 1 in every 2,761,484; wounded 61, or 1 in every 181,277. New York, Lake Erie and Western carried 5,385,669; killed 2, or 1 in every 2,692,384; wounded 19, or 1 in every 283,456. New York, West Shore and Buffalo carried 1,360,608; killed 5, or 1 in very 272,122; wounded 18, or 1 in every 75,589. Delaware and Hudson Canal carried 559,351; killed5, or 1 in every 111,870; wounded 18, ort in every 31,075.

The Manhattan Railway Company (elevated) transported 16 passengers to the mile; the New York Central transported 2 passengers to the mile.

From the railway mortality statistics of England and some parts of the continent of Europe, recently published, we find that the French railways annually kill one in every 2,000,000 passengers transported; English railways annually kill one in every 5,250,000 passengers transported; Belgian railways annually kill one in every 9,000,000 passengers transported; Prussian railways annually kill one in every 21,500,000 passengers transported; French railways annually wound one in every 500,000 passengers transported; English railways annually wound one in every 750,000 passengers transported; Belgian railways annually wound one in every 9,000,000 passengers transported; Prussinn railways annually wound one in every 4,000,000 passengers transported.

Indiana Railroads.—INDIANAPOLIS, July 20th.—The State Board of Equalization, consisting of the Governor, Lieutenant-Governor, Auditor, Treasurer and Secretary of State, concluded its work this afternoon, after having been in session forty days. The valuations placed upon the various railroads in Indiana was somewhat increased from last year, but no material changes were made, the board considering this the wisest policy, inasmuch as next year, the regular sixth year's assessment of all the property in the State will be made. The totals are as follows: Length of main track, 5443 miles; valuation, $39,509,200. Second main track, 68 miles; valuation, $402,260. Side track 1,051 miles; valuation, $2,503,958. Rolling stock, $11,005,428; improvements on right of way, $1,470,838. The figures for 1884 as reported, were as follows: Main track miles 5,490; valuation $39,159,690; second main, 68 miles; valuation, $405,580; side, 990 miles; valuation $2,700,948; rolling stock, $11,354,113; improvements, $1,429,350. The total increase in the valuation of railroad property in the State is $349,439. Eollowing is the assessment per mile on leading roads of the State on the various tracks and improvements: Baltimore and Ohio, main track, per mile, $10,000; side, $2,000; rolling stock, per mile, $1,800; improvements, $65,840. Bloomfield Narrow-Gauge, main track, $1,200; side, $300; rolling stock, $540; improvements, $750. Bedford and Bloomfield, main track, $1,200; side, $400; rolling stock, $325; improvements, $1,600. Cairo and Vincennes, main, $4,500; rolling stock, $2,000. Chicago and Atlantic, main, $5,000; side, $2,000; rolling stock, $2,500; improvements, $34,010. Chicago, Cincinnati and Louisville, main $4,000; side, $1,500; rolling stock, $2,265. Chicago and Great Southern, main, $3,000; side, $1,200; rolling stock, $500; improvements, $280. Evansville, Terre Haute and Chicago main, $7,000; side, $2,000; rolling stock, $3,500; improvements, $8,980. Chicago and Grand Trunk, main, $10,000; side, $,3000; rolling stock, $4,000; improvements, $19,925. Chicago St. Louis and Pittsburg, main, $8,800; side, $3,000; rolling stock, $2,500; improvements, $183,150. Cinc'nnati, Indianapolis, St. Louis and Chicago, main $9,000; side 2,500; rolling stock, 2,500; improvements $33,175. Cincinnati, Hamilton and Indianapolis, main, $7,250; side $2,000; rolling stock, $1,650; improvements, $17,125. Cincinnati, Wabash and Michigan, main, $5,000; side; $2,000; rolling stock, $800; improvements, $15,450; Cleveland, Columbus, Cincinnati and Indianapolis main, $11,500; side, $2,500; rolling stock, $4,000; improvements, $99,220. Indianapolis and St. Louis, main, $8,500; side, $2,900; rolling stock, $2,380; improvements, $11,795. Evansville and Terre Haute, main, $7,650; side $3,000; rolling stock, $3,000; improvements, $64,795. Fort Wayne, Cincinnati and St. Louis, main, $3,000; side, $2,000; rolling stock, $8,00; improvements, $10,250. Grand Rapids, main, 7,000; side, $2,500; rolling stock, $2,300; improvements, $5,025. Cincinnati, Richmond and Fort Wayne, main, $4,500; side, $2,500; rolling stock, $560; improvements, $7,375. Indiana, Bloomia

ton and Western, main, $6,700; side, $2,000; rolling stock, $2,5000; improvements, $0,880. Indianapolis, Decatur and Springfield, main, $5,000; side, $2,000; rolling stock, $1,450; improvements, $30,900. Lake Erie and Western, main, $6,000; side, $2,000; rolling stock, $1,400; improvements, $16,725. Lake Shore and Michigan Southern, main, $20,000; side, $3,000; rolling stock, $3,300; improvements, $110,345. Louisville, Evansville and St. Louis, main, $4,000; side, $2,000; rolling stock, $1,200; improvements, $17,785. Louisville, New Albany and Chicago, main, $5,000; rolling stock, $1,500; improvements, $4,350 New York, Chicago and St. Louis, main, $6,000; side; $2,000; rolling stock, $3,600; improvements, $27,485. Ohio and Mississippi, main, $9,000; side, $2,500; rolling stock, $1,700; improvements, $10,505. Pennsylvania Company, operating Pittsburg, Fort Wayne and Chicago, main, $20,000; side, $6,000; rolling stock, $4,600; improvements, $176,410. Jeffersonville, Madison and Indianapolis, main, $9,000; second $4,000; sidef $1,000; rolling stock $1,500; improvements, $40,550. Indianapolis and Vincennes, main, $4,000; side, $2,000; rolling stock, $900; improvements, 15,395. Terre Haute and Indianapolis, main, $13,000; side, $2,500; rolling stock, $900; improvements, $15,395. Terre Haute and Logansport Division, main, $3500; side $2,000; rolling stock, $800; improvements, $1,365. Wabash, St. Louis and Pacific, main, $13,000; side $2,500; rolling stock, $2,000; improvements, $134,045. Whitewater Valley, main, $3,000; side, $200; rolling stock, $400; improvements $3,300.

Index to Periodical Literature.

Artillery.—(*See* Cannon).

Blasting.—(*See* Harbor).

Blasting.—*Notes on Electric Blasting in China.*—Describes the operations on the works of Engineering and mining company of North China. Two descriptions of Siemens dynamo-exploders were found most suitable, but the Siemens fuses were abandoned for the Abel which is more durable. The gunpowder, cased in paper cartridges, was of native manufacture, and native labor was employed. The different forms of exploders, fuses, etc., are described and illustrated, as well as the mode of working, precautions and accidents. C. W. Kinder, A. M. I. C. E., *Min. Proc, Inst. C. E., vol. lxxx*; *Session*, 1884-85.

Cannon.—An article descriptive of the new French gun brought out by Col. De Bange. It is composed of steel inner tube strengthened by a series of hoops put on hot; there are four layers of hoops at the breech, reducing to one layer at the muzzle. It is a breech-loader. 340 millimetres (13.25 inches) bore. The carriage is on a pivot and has a hydraulic brake, the trunnions are carried on a curved frame pivotted at the rear. The gun is 11.06 meters (36.-25 feet) long; it is described, in detail, with several drawings, and notes on the projectiles, and formulæ for its efficiency are also given. *Le Génie Civil*, July 4, 1885, pp. 145 to 147.

Dynamometers.—A paper read April 29, before the Engineers Club of St. Louis, by C. F. White, describes the construction and operation of several forms, especially of a new one lately brought out, the "Wales Portable Dynamometer," which is given in detail in formulæ for results, and a description of a trial for accuracy. Several illustrations, and two diagrams from the "Wales" machines. *Journal of the Assoc. of the Eng. Soc.* July, 1885, pp. 333 to 345.

Electric Blasting.—(*See* Blasting).

Elevator.—*Hydraulic Canal Elevator.*—On the Neufasse Canal, near St. Omer, France. There are two parallel troughs, closed with gates, each supported on a central ram, and are in equilibrium. They descend into a dry basin, the water being then let in and the barge floated out. Each trough is 40 metres (131 feet) long by 5.60 metres (18 ft. 6in.) wide, and has 2 feet depth of water. All the water for operating is taken from the upper canal so no fuel is required. The rams are 2 metres (6ft. 6in.) diam. and 13.13 metres (43 feet) stroke. Illustrated. A similar elevator at Anderton, England, is described. *Engineering*. July, 10, 1885, pp. 29 to 31.

Harbor.—*The Blasting and Removal of Rocks Under Water, and the Construction of a Deep Water Quay at Blyth Harbor (England.)* The material was rock, shale, and clay, the surface of the reef dry at low-water. Boring carried on from rafts, holes 2¾ in. diam. Various explosives tried and gelatine found most suitable. Debris removed by a bucket dredge, a "Priestman" grab also employed. Whole cost of removal averaged $1.46 per cubic yard.

Quay.—Length 712 feet; height from floor to coping, 33 feet 6 inches; depth of low water 15 feet; high water 29 feet 6 inches. Batter 1 in 13. Timber piling and framing, and concrete wall. Piles 36 feet long, 13 inches square, iron shod, driven 5 feet into the rock. Planking fixed across face and liquid concrete deposited behind planking afterwards removed. The operations composition of concrete, quantities, and cost are given in detail, with plan and detail drawings. *Min. Proc. Inst. C. E.*, vol. lxxxi. Session 1884-85, part 3.

Locomotive.—A large engine for the Paulista Ry., Brazil Gauge 5 feet 3 inches. Inside cylinders 20 inch by 24 inch, valve chests outside Leading two-wheeled truck, four pairs coupled wheels 48 inch diameter. English construction, with plate-frames. Total weight 100,800 pounds. The tender has one pair of fixed wheels, and a four wheeled trailing truck. The nature of track and results of trials are given, with general and detail drawings. *Engineering*, July 10, 1885, pp. 34, 35.

Magnetism.—*Experiments on the Permanent Magnetism of Steel.*—The test bars were 100 by 20 by 20 millimetres (4 in. by ¾ by ¾). The electro-magnet and batteries are described, the Bunsen being found preferable to the Leclanchè. Several methods of ascertaining the magnetic power are described, the one adopted being given in detail and illustrated. Formulæ are given and a table showing the results from different bars. Experiments made at the Crensot Iron-works in France. *Le Genie Civil*, July 4, 1885, pp. 148 to 150.

Quay.—*See* Harbor.

Railroad.—*Railroad Building in Mexico.*—A paper read by L. Bradford before the Boston Soc. of C. E., June 17. Treats of peculiarities of construction and location not met with in the States, and refers specially to the Central R. R. Metric system used. The nature of country passed through is described and the style of work. *Journal of the Assoc. of Eng. Soc.* July, 1885, pp. 345 to 350.

Retaining Walls.—*Treatise on the Resistance of Materials in Retaining Walls.*—By M. Hétier. An exhaustive paper on the nature of the various strains, with notes as to the proper construction under varying circumstances, the manner in which they fail, and other matters. It deals with walls of various forms, with and without counterforts, and of different materials. It is replete with formulæ, and includes several drawings and diagrams. *Annales des Ponts et Chaussées.* May 1885, pp. 795 to 989.

Rolling Stock.—A comparison of the cost, earnings expenses, and other details of the rolling-stock of two important English railroads—the Midland and the North Eastern. A table is given of the mileage, expenses, etc., of the two roads, and the details of cost are fully considered. *Engineering*, July 10, 1885, pp. 25, 26.

Viaduct.—*The Mahninot Viaduct.*—On the Montanban & Cahors Ry., in France, over the river Pax. Length 119.64 metres (654 feet) long, on a radius of 500 metres (1640 feet), and a grade of 1 in 100. Brick arches (about 30 feet span) and piers with stone facings. Illustrated. Reproduced from Annales Industrielles. *Railroad Gazette*, July 24, 1885, p. 468.

Wind.—*Wind Force and Velocity.*—A short paper on wind force as applying to ships, with notes on experiments made at different places. Tables are given compiled by various authorities, including Beaufort's table as used in the Royal Navy. *Engineering*, July 10, 1885, p.p. 28, 29.

Market Report of Engineering Materials.

New York, July 30, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.			
Angles		1.9c. @	2.2c.
Tee		2.2 @	2.4c.
Beams and channels		3.0c. @	
Tank		2. @	2.1c
Shell		3c. @	3¼c
S eel plates, Tank		2¾c. @	3c.
WROUGHT-IRON PIPE., PITTSBURGH.			
Butt welded, black	Discount	45 @	50
" " galvanized	"	35 @	40
Lap welded black	"	65c. @	
" Galvanized	"	45 @	50
Boiler tubes	"	60 @	
RAILS.			
Steel (large lots at mill)		$27.00 @	27.50
Old rails		16.50 @	17.00
Old rail steel		16.50 @	17.00
R. R. spikes		1.8 @	1.9c
R. R. splice-plates		1.55 @	1.7
R. R. Track Bolts		2.55 @	2.65
Barb-wire fencing, galvanized		4¾c. @	5¾c.
" " painted		3¾c. @	4¾c.
Corrugated iron			
Nails			
Iron		2.25	
Steel		2.40	

METALS.

COPPER.			
Lake Superior		11. @	11¼
Other Brands		10¾ @	11¼
LEAD.			
Com. Domestic		4.12½ @	4.15
Lead Pipe		.06¾	
Tin-Lined Lead Pipe		.15	
Sheet Lead		.06¾	
ZINC.			
Sheet		0.05 @	0.05¼

BRICK.

(Cargoes afloat)			
Haverstraw	per M.	$6.25 @	6.50
Fishkill			
Up-River		5.50 @	6.25
Jerseys		5.25 @	6.00
Long Island			
" pale		3.00 @	3.50
FRONTS.			
Croton red		13.00 @	14.00
" dark		13.00 @	14.00
" brown		12.00 @	13.00
Philadelphia pressed		24.00 @	25.00
Trenton "		24.00 @	25.00
Baltimore "		37.00 @	41.00
Buff "		33.00 @	35.00
Enameled English		65.00 @	130.00
" American		85.00 @	120.00
Fire brick		25.00 @	40.00

CEMENT.

PORTLAND.			
Gibb's English	400 lbs, per bbl	2.75 @	2.90
K. B. & S.	"	2.85 @	3.00
J. B. White & Bros., Portland Cement		2.65 @	3.00
do Keene's Superfine,		8.00 @	10.00
do " Coarse,		5.00 @	6.00
Roman		2.75 @	3.50
Largerdorfer German	"	2.55 @	2.80
Dyckerhoff, "	"	2.90 @	3.25
Stettiner "	"	2.60 @	2.65
Hanover "	"	2.60 @	2.65
Vorwohler, Lion	"	2.90 @	3.25
Alsen, "	"	2.55 @	2.60
Fieve	"	2.40 @	2.50
Saylor's American		2.15 @	2.40
Windsor	U. S. C. Co.	1.00 @	1.10
Standard			1.15
Cable's Portland		2.15 @	2.40
ROSENDALE cements		1.00 @	1.10

LIME.

Rockland common	per bbl	1.00
" finishing		1.20
State, common		.90
" finishing		1.10
Kingston, ground		0.95
Add 25c. to above figures for yard rates.		

STONE.

Cargo rates at New York.

Amherst freestone, No. 1	per cub. ft.	0.90 @	95
" " No. 2	"	0.75 @	0.80
" " light drab	"	0.80 @	0.95
Berlin " in rough	"	0.75 @	1.00
Berea "	"	0.75 @	1.00
Brownstone, Portland, Ct.	"	1.00 @	1.30
" Belleville, N. J.	"	0.75 @	1.25
Granite, rough		0.60 @	1.25
Common building stone	per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.		0.40 @	3.00

SLATE.

Purple roofing	per square	6.00 @	7.00
Green	"	6.00 @	7.00
Red	"	15.00	
Black Penna. (at New York)	"	4.50 @	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box	per M.	18.00 @	20.0
Choice	"	55.00 @	80.
Tally plank, 1¼ in. 10 in. dres'd.	each.	.44 @	.50
Tally boards, dressed com.	"	.28 @	.30
SPRUCE, Boards dressed	"	.25 @	.28
Plank, 1¼ in	"	.28 @	.30
" 2 in.	"	.38 @	.40
" 2 in. dressed	"	.43 @	.45
Timber	per M.	20.00 @	22.00
HEMLOCK, Boards	each.	.18 @	.20
Joist, 2¼ × 4 to 4 × 6 in	"	.17 @	.44
OAK	per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2½ in	"	35.00 @	40.00
YELLOW PINE, Girders	"	25.00 @	30.00
Dressed flooring	"	28.00 @	35.00
SHINGLES, Extra shaved pine, 16in.	"		
" sawed 18 in.	"	5.75 @	6.00
LATH, Cargo rate	"	2.10 @	2.25

PAINT.

Lead, white, American dry	per lb	.04¾ @	.05
" " " in oil pure	"	.05½ @	.05¾
English, B. B. in oil	"	.08½ @	.08¾
Red, American	"	.05½ @	.05¾
Litharge	"	.05 @	.05¼
Venetian red, American	"	.01 @	.01¼
Indian red	"	.05 @	.10
Vermillion, American lead	"	.11 @	.11½
Paris green	"	.15 @	.19
Umber, Amer. raw and powdered	per lb.	.01¼ @	.01¼
Drop black, Amer.	"	.08 @	.12
" " "	"	.09 @	.11¾
Chrome green	"	.05 @	.15
Oxide zinc, American	"	.03¾ @	.04
" French	"	.06¼ @	.06½

New Railroad.—Ground has been broken for the construction of a railroad between New Oxford and York Springs, Adams country, Pa. Work was commenced on Tuesday of last week, near New Chester, with assurance from the president that it will now be pushed to completion. According to the contract, it must be completed within the next eleven months.